DRAFT CONCEPTUAL SMELTER HILL AREA UPLANDS RESOURCES RESTORATION PLAN

Prepared by

Montana Department of Justice

Natural Resource Damage Program

DECEMBER 2007

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1301 E. Lockey
Helena, MT 59601

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Section 1: Introduction

Natural resource damages under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 et seq., (CERCLA) are designed to compensate trustees[1] for injury[2] to natural resources[3] that are residual to CERCLA response actions.[4] In 1995, the State of Montana (State) issued a Restoration Determination Plan (RDP) as part of its natural resource damage assessment. The RDP quantified the amount of natural resource damages to which the State was entitled in order to restore injured natural resources in the Upper Clark Fork River Basin (UCFRB). Among other resources, the RDP identified the costs to restore the Mount Haggin, Stucky Ridge, and Smelter Hill Injured Areas (Injured Areas). The RDP for the Injured Areas was revised in 1999, and again in 2002.[5]

The State, the United States, and AR have now lodged a consent decree with federal district court.[6] Upon the effective date of the consent decree, AR has agreed to pay $72.5 million plus interest, to resolve the State natural resource damage claims for the State's Step 2 Sites. The consent decree allocates 19.45% of the consent decree settlement money, after payment of assessment and litigation costs, to the Smelter Hill Area Uplands State Restoration Account to restore, rehabilitate, replace or acquire the equivalent of the injured natural resources as provided in the State's restoration plan. This results in approximately $13.3 million for the Injured Areas. This Draft Conceptual Smelter Hill Area Uplands Resources Restoration Plan (DCRP) presents the State's plan for this restoration. The State relied on the RDP in the development of this DCRP.

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[1] The State of Montana is a trustee of natural resources within the state. CERCLA Section 107(f)(1), 42 U.S.C. § 9607(f)(1).

[2] As trustee, the State is entitled to "damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from" the release of a hazardous substance. CERCLA Section 107(a)(4)(C), 42 U.S.C. § 9607(a)(4)(C).

[3] "The term 'natural resources' means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by" the State. CERCLA Section 101(16), 42 U.S.C. § 9601(16).

[4] "The terms 'respond' or 'response' means remove, removal, remedy, and remedial action." CERCLA Section 101(25), 42 U.S.C. § 9601(25).

[5] The 2002 RDP also included, as attachments, *two reports, the Ecological Restoration Plan for the Mount Haggin Injured Area* and the *Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Areas, which were prepared by Bitterroot Restoration, Inc.*. These reports characterized the injured areas and reference areas, and compared restoration alternatives including specifications of restoration treatments, descriptions of restoration species, detailed restoration prescriptions, and cost estimates for the various restoration prescriptions.

[6] *Consent Decree for the Clark Fork River Operable Unit and for Remaining State of Montana Clark Fork Basin Natural Resource Damages Claims*, Civil Action No. CV89-039-BU-SEH (lodged - 2007).

The Injured Areas are included in the Anaconda Smelter NPL Site. Therefore, in addition to the RDP, the State also relied on certain EPA Final Design Reports / Remedial Action Workplans (RAWPs/FDRs) in the development of the DCRP. As discussed above and in Section 4, natural resource damages are residual to CERCLA response actions. The State also relied on the RAWPs/FDRs because, under the terms of the consent decree, the State agreed to meet certain EPA remedial requirements through restoration on State-owned property within the Injured Areas.[7] These remedial consent decree requirements, including attainment of performance standards, [8] and obligation to perform additional remedial work and emergency response, are set forth in Appendix G.

This document characterizes the condition of natural resources in the Injured Areas, briefly describes the EPA response actions, summarizes the residual natural resource injury, and presents the State's actions for restoring the natural resources in the Injured Areas.

[7] These EPA remedial requirements are referred to in the consent decree as the State Property Remedial Commitments.

[8] "Performance Standards" are the cleanup standards and other measures of achievement of the goals of the remedial action contained in a record of decision, including applicable, relevant and appropriate requirements (ARARs).

Section 2: Description of the Site and Injury[9]

The Injured Areas have been injured due to releases of hazardous substances from mineral processing activities. Enormous volumes of hazardous substances, including copper, arsenic, and cadmium, were continually released into the air by these operations and subsequently deposited onto the land.

The primary source of hazardous substances to the Injured Areas was emissions from the Anaconda Smelter. Emissions from the Anaconda Smelter stack resulted in the deposition of hazardous substances across hundreds of square miles of surface soils surrounding and downwind of the stack. This resulted in injury to soils, vegetation, wildlife habitat, and wildlife.[10]

The injury determination undertaken by the State for upland resources delineated those areas displaying gross (visible) injury attributable to the deposition of hazardous substances released as smelter emissions and/or fugitive dust emissions. Grossly injured resource areas were defined as those areas which exhibit complete or virtual elimination of major indigenous plant associations, little or no regeneration of major indigenous plant associations, and extensive topsoil exposure and erosion due to vegetation loss.

Upland areas which met the grossly injured criteria extend across approximately 17.8 square miles (11,356 acres) of land. The grossly injured area encompasses the eastern portion of Stucky Ridge and the hills on the north side of Lost Creek Road (2,408 acres), areas to the west and south of Smelter Hill (4,649 acres), and portions of the Mount Haggin Wildlife Management Area east of the Mill Creek Highway (4,299 acres).

Soils in the Injured Area have elevated concentrations of hazardous substances including arsenic, cadmium, copper, lead, and zinc. Laboratory tests have confirmed that these soils are phytotoxic, which is consistent with visual observation of gross injury. Metal concentrations are highest in the upper two inches of soil. Elevated metal concentrations on the soil surface and upper soil layers prevent vegetation establishment, which explains the lack of natural recovery in the area. Absent human intervention, concentrations of hazardous substances in the soil will not be reduced sufficiently to allow for revegetation in a reasonable length of time.

In general, across the Injured Areas, there has been a shift in plant community types from coniferous forests and grassland to areas of sparse cover consisting of noxious weeds and some grasses or bare ground. In addition, stands of aspens are more

[9] The information contained in this section is summarized from the State's 1995 Terrestrial Resources Injury Assessment Report.

[10] Mining and mineral-processing wastes and contaminated soils are also sources of on-going releases of hazardous substances through transport by the wind and redeposition onto the land surface and through surface runoff into water resources.

prevalent than they would have been had the area not been injured. Approximately one square mile of aspen is present on both the Smelter Hill and Mount Haggin Injured Areas.

Absent hazardous substances in the soil, the Injured Areas on Smelter Hill and Mount Haggin would have vegetative cover consisting of approximately 70% forest and 30% grassland, and the Injured Area on Stucky Ridge would have vegetative cover consisting of approximately 30% forest and 70% grassland. Of the total 11,356 acres that exhibit gross injury, 6,993 acres (62%) would have been primarily forestland and 4,373 acres (38%) would have been primarily grassland.

The elimination of upland vegetation communities in the grossly injured area has caused a severe disruption to the ecosystem. Most notable has been the drastic reduction in the quantity and quality of wildlife habitat.

Section 3: CERCLA Response Actions

The Anaconda Regional Water, Waste, and Soils Operable Unit Record of Decision (September 1998) (ROD) including its upcoming Explanation of Significant Differences (ESD), as well as the related RAWPs/FDRs, set forth the remedial actions and the performance standards within the Anaconda Smelter NPL Site. The RAWPs/FDRs pertinent to the Injured Areas are the RAWPs/FDRs for Remedial Design Unit (RDU) 1 Stucky Ridge, RDU 3 Smelter Hill Uplands, RDU 14 Smelter Hill, and RDU 15 Mount Haggin Uplands.[11]

To accomplish the ROD objectives, the RAWPs/FDRs generally require the following:

- Reduction of arsenic concentrations to meet applicable human health levels using a combination of revegetation treatment techniques

- Application of revegetation techniques, which may include deep tilling with lime additions and soils amendments, to reduce surface soil arsenic concentrations to human health levels and establish a diverse, effective, and permanent vegetation cover

- Application of revegetation technologies to establish a self-sustaining assemblage of plant species capable of stabilizing the soils against erosion and minimizing transport of contaminants to surface and ground water in order to meet water quality standards, maximizing water usage, re-establishing wildlife habitat, and accelerating successional processes

- Application of best management practices (BMPs), as appropriate

- Sediment basins to control storm water run-off where appropriate

- Institutional controls to maintain the integrity of remedial actions and prevent exposure to contaminated soil

- O&M activities

The State recognizes that implementation of the remedy will help provide site stability, reduce exposure of wildlife to contaminants of concern, and help provide sustainable vegetative cover in a number of areas.

[11] These FDRs provide for remedial actions within the related Injured Areas, but do not address all of the State's restoration goals and objectives.

Section 4: Residual Injury to be Addressed by Restoration

Residual injury is the injury to natural resources that remains substantially unimproved following implementation of the remedy. This concept is predicated on the fact that response actions can improve the condition of injured natural resources and thereby lessen natural resource injury. Although the State recognizes the significant remedy effort, the remedial actions fall short of restoration.

The State analyzed the areas of residual injury within the Injured Areas, and focused on three restoration categories for use of the consent decree settlement moneys. First, the remedial action on the Mount Haggin Injured Area specifies the revegetation of 137 acres in the Cabbage Gulch area in the north end of the Mount Haggin Injured area. The State believes residual injury remains outside of Cabbage Gulch, most significantly to the 850 acres of Bare and Degraded Areas identified in the RDP. These 850 acres of Bare and Degraded Areas within the 4,300 acre Mount Haggin Injured Area lack vegetation, soil organisms, and soil organic matter that provide nutrients and moisture retention. These Bare and Degraded Areas will therefore be addressed as discussed in Section 5.[12]

Second, the State determined that further restoration should be performed where the State is performing remedial action under the consent decree referred to in Section 1 and footnote 6.[13] The integration of remedial action and restoration presents a cost-effective way to restore natural resources closer to baseline condition. The State is therefore augmenting the remedial action at the State-owned portion of Section 36 in the Stucky Ridge Injured Area and at Cabbage Gulch in the Mount Haggin Injured Area. These combined restoration/remediation actions are described in Section 5.

Third, it is expected that the above described restoration actions will not deplete the restoration account dedicated to the Injured Areas and there will be approximately $4.0 million, plus interest, in the account after these restoration actions are implemented. It is anticipated that additional restoration will be implemented on land owned by Anaconda/Deer Lodge County within the Injured Areas using the remaining money in the account. Restoration actions within these areas will be coordinated with remedy for these areas. The precise scope of this additional restoration will be determined at a later date, although it is presently expected that such restoration will be based, at least in part, on the proposed restoration actions presented in the previously referenced report, *Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Area.*

[12] The 2002 RDP and its attachment, the *Ecological Restoration Plan for the Mount Haggin Injured Area,* identified 267 acres of bare areas (BA), 246 acres of steep degraded grassland areas (SDG), 344 acres of degraded grassland areas (DG) as requiring restoration treatments. Together, these impacted areas compromise the 857 acres of Bare and Degraded Areas identified in the RDP. These areas are approximately identified in the Montana Natural Heritage map, Figure 1.

[13] As discussed in Section 1, the State agreed to meet certain EPA remedial requirements through restoration actions on State-owned property within the Injured Areas.

Section 5: State Actions

5.1 Restoration of the Bare and Degraded Areas in the Mount Haggin Injured Areas. The Mount Haggin restoration addresses vegetation of the Bare and Degraded Areas (approximately 850 acres). These areas are approximately identified on Figure 1. For these Bare and Degraded Areas, the State plans the following restoration activities:

- Lime application. Exact liming rates and lime type will be determined during design and is expected to be between 0 and up to 8 tons per acre. Aerial application is expected to be the most cost-effective method of application.

- Tree and shrub planting on most of the 850 acres. Tree and shrub plantings of about 500 stems per acre will be placed in these areas. Containerized plants will be at least 10 cubic inches in size and a year old. The exact spacing and types or plants will be determined during design. It is expected that islands of vegetation will be planted rather than uniform spacing throughout the area.

- Aerial fertilization in years three and five. Fertilization rates will be most likely be at a 300 - 400 pounds per acre rate and spread via helicopter.

- Seeding. Some areas will require mechanical incorporation of seed where equipment can be utilized; other areas will need seed applied by hand or via helicopter. Seed mixes and application rates are found in Appendix C.

The State will apply the vegetation considerations set forth in Appendix C.

5.2 Combined Restoration/Remediation in the Mount Haggin Injured Area. The State will perform the remedial action required in the RDU 15 RAWP/FDR, attached as Appendix D. Together, Figures 2A, 2B and the accompanying legend present the polygon delineation and required remedies. The RAWP/FDR includes, but is not limited to, the following actions:

- Tree planting (500 plants/acre) on 112 acres of steep slope areas. The exact spacing and types or plants will be determined during design. It is expected that islands of vegetation will be planted rather than uniform spacing throughout the area.

- Dozer basins on 18 acres. Dozer basin spacing on the 18 acres of SSR-3 areas. Exact placement will be determined during design.

- Tillage to 6 inches on 16 acres. Tillage of 6 inches to reduce metal concentrations by mixing the surface soil layers with the lower soil layers in order to help provide a suitable growth medium. Incorporation of organic matter may also be necessary.

- Tillage to 12 inches on 9 acres. Tillage of 12 inches to reduce metal concentrations by mixing the surface soil layers with the lower soil layers in order to help provide a suitable growth medium. Incorporation of organic matter may also be necessary.

- Fertilization and lime application on 25 acres of tillage areas. Liming in tilled areas will be at a rate of approximately 6 tons per acre. Fertilization, which will be incorporated during seedbed preparation, will consist of 12-16-30 (% nitrogen, % phosphate and % potassium) fertilizer.

- Seeding of all 137 acres.[14] The 25 acres of tillage areas will be mechanically seeded. The remaining 112 acres will be seeded by hand, air or mechanically depending on the steepness of slope.

- Best Management Practices for stormwater concerns. BMPs are necessary during construction and until vegetation is established.

- Sediment Basins. Sedimentation basins will be established and maintained in Cabbage Gulch, Joyner Gulch and Muddy Gulch.

- Weed control as necessary.[15] It is expected that aerial and hand application of chemicals, along with biological controls, will be necessary to control knapweed, whitetop, and leafy spurge. This effort will be the first component of remedial action on the site.

In addition, the State will perform the following restoration activities at Cabbage Gulch:

- Lime application on 112 acres of steep slope areas. Exact liming rates and lime type will be determined during design but is expected to be between 0 and up to 8 tons per acre. Aerial application is expected to be the most cost-effective method of application.

- Aerial fertilization of all 137 acres in years three and five. Fertilization rates will be most likely be at a 300 – 400 pounds per acre rate and spread via helicopter. Exact fertilization rates per acre will be determined during design.

The additional restoration actions may affect the timing and sequencing of the Cabbage Gulch activities since remediation and restoration actions will occur concurrently. Mount Haggin restoration, including the Cabbage Gulch remedial

[14] The seed mix will be modified slightly from that prescribed in the RDU 15 FDR and will instead consist of the species set forth in Appendix C.

[15] The State plans aggressive weed control in this area.

components, will occur in 2008 – 2013. Timing of anticipated activities for Mount Haggin activities are:

- 2008 or 2009: weed control
- 2010: lime application
- 2011 - 2013: fertilizing, seeding and planting
- 2014 - 2016: monitoring

State actions at the Mount Haggin Injured Area, consisting of the restoration of the Bare and Degraded Areas and the combined restoration / remediation at Cabbage Gulch, and other areas is estimated to be $6.7 million. More detailed costing is presented in Appendix F.

The State will apply the vegetation considerations set forth in Appendix C.

5.3 Combined Restoration / Remediation on the Stucky Ridge Injured Area

The State will perform the remedial action required in the RDU 1 RAWP/FDR, attached as Appendix E on the State-owned portion of Section 36 (480 acres). Figure 3 presents the polygon delineation and required remedies. The RAWP/FDR includes, but is not limited to, the following actions:

- Tillage to a depth of 12 inches. Tillage of 12 inches on 335 acres to reduce metal concentrations by mixing the surface soil layers with the lower soil layers in order to help provide a suitable growth medium. Incorporation of organic matter may also be necessary, however, it is not expected that significant organic matter additions will be necessary, since preliminary and nearby data shows significant amounts of organic matter in the soils.

- Lime application. Liming in tilled areas will average about 22 tons per acre and will occur after one tilling pass.

- Seeding.[16] Along with the seed mix proposed will be the addition of shrub seed to enhance species composition.

- Fertilizing. Fertilization, which will be incorporated during seedbed preparation, will consist of 12-16-30 (% nitrogen, % phosphate and % potassium) fertilizer.

- Planting of shrubs and trees on 90 acres designated as steep slope areas. The exact spacing and types or plants will be determined during design. It is expected that islands of vegetation will be planted rather than uniform spacing throughout the area.

[16] The seed mix will be modified slightly from that prescribed in the RDU 1 FDR and will instead consist of the species set forth in Appendix C.

- Dozer basins on 50 acres of steep slope areas. Dozer basin spacing on the 50 acres of SSR-3 areas will be determined during design.

- Stone check dams and other best management practices. BMPs are necessary during construction and until vegetation is established.

- Weed control. Aerial chemical weed control has been occurring in Section 32 for a number of years. Further controls will be evaluated during design.

In addition, the State will perform the following restoration activities at the State-owned portion of Section 36:

- Lime application on 90 acres of steep slope areas. Exact liming rates and lime type will be determined during design and is expected to be about 20 tons per acre. Aerial application is expected to be the most cost effective method of application.

- Stripping and grading on a portion of the tillage areas. These areas contain highly impacted soils and are proposed for stripping of the upper 4 inches and consolidation in an area on Stucky Ridge in Section 36. Tilling and liming of the underlying subgrade will be done after stripping is performed.

- Planting of shrubs and trees on half the tillage and rock areas. 177 acres are slated to be planted with shrubs and trees. It is expected that islands of vegetation will be planted rather than uniform spacing throughout the area.

- Aerial fertilization on the tillage and steep slope areas in years three and five. Fertilization rates will be most likely occur at a 300 - 400 pound per acre rate and spread via helicopter. Exact fertilization rates per acre will be determined during design.

The additional restoration actions may affect the timing and sequencing of activities on the State-owned portion of Section 36. The State will apply the vegetation considerations set forth in Appendix C. Stucky Ridge restoration / remediation will occur from 2008 to 2012. Timing of anticipated activities for Stucky Ridge are:

- 2008: weed control
- 2009: stripping, lime application
- 2010 - 2012: fertilizing, seeding and planting
- 2013 - 2017: monitoring

No remedial action will be performed by the State within the Stucky Ridge Injured Area outside of the State-owned portion of Section 36, although EPA will require remedial action be performed by the potentially responsible party, as discussed in Section 3, and as set forth in the RDU 1 and RDU 3 RAWPs/FDRs. No remedial action will be performed by the State within the Smelter Hill Injured Area, although

EPA will require remedial action be performed by the potentially responsible party, as discussed in Section 3, and as set forth in the RDU 14 RAWP/FDR.

The State-owned portion of Section 36 combined restoration/remediation is estimated to cost $2.7 million. More detailed costing is presented in Appendix F.

5.4 Further Restoration on County-Owned Lands Within the Injured Areas

The costs for the planned restoration on State-owned land in the Injured Areas are estimated at $9.4 million. As discussed in Section 1, the consent decree allocates approximately $13.3 million, plus the interest earnings on this amount, to the Smelter Hill Area Uplands State Restoration Account. The expected costs for implementation of the actions on State-owned lands are an estimate, but it is expected that about $4.0 million, or more, will remain in the Smelter Hill Area Uplands State Restoration Account after implementation of those actions. This money will be used to restore, rehabilitate, replace or acquire the equivalent of the injured natural resources on the County-owned lands within the Injured Areas, including restoration consistent with the restoration actions specified in the RDP. This DCRP may be amended to provide for specific additional restoration actions that are coordinated with remedy actions on these County-owned lands after consideration of further input by the County and the public as to what particular restoration actions should be implemented.

REFERENCES

ARCO. Stucky Ridge Uplands Final Remedial Action Work Plan/Final Design Report for RDU I. Anaconda Smelter NPL Site. ARCO, June 2005.

ARCO. Mt. Haggin Uplands Final Remedial Action Work Plan/Final Design Report for RDU 15. Anaconda Smelter NPL Site. ARCO, November 2007.

ARCO. Final 2002 Stucky Ridge Remedial Action Construction Completion Report. Anaconda NPL Site. ARCO, February 2006.

ARCO. Final 2004 Smelter Hill Final Design Report for RDU 14. Anaconda Smelter NPL Site. ARCO, December 2004.

BRI. Ecological Restoration Plan for the Mount Haggin Injured Area. Bitterroot Restoration Inc. January, 2002.

BRI. Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Areas. Bitterroot Restoration Inc. January 2002.

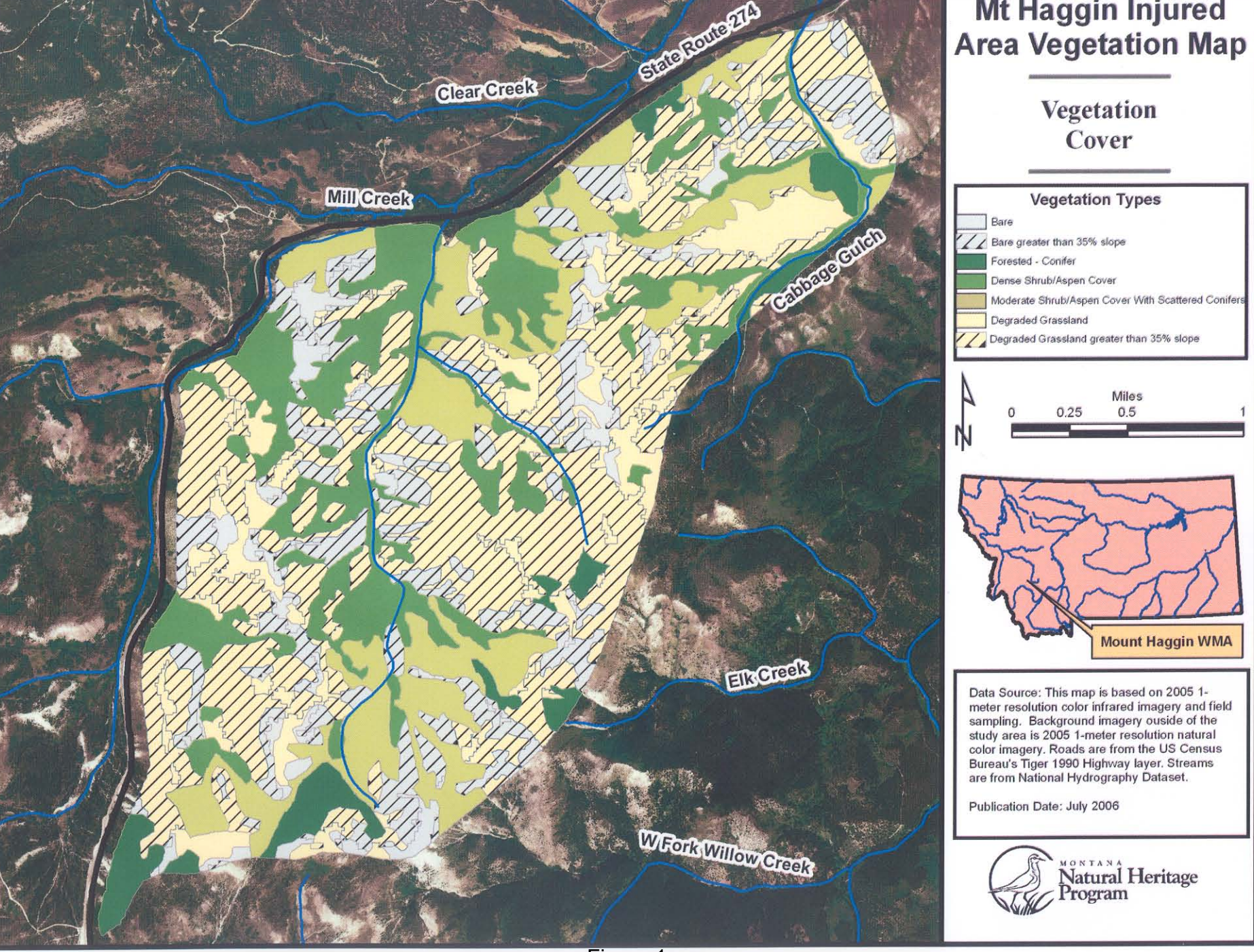
Hogan, William. Heli-works; 1001 Montana Avenue, Deer Lodge, Mt.; phone cost quotations: 2006.

Kudray, Gregory, 2006. Mount Haggin Injured Area Vegetation Map Report. Montana Natural Heritage Program, August 2006.

Prodgers, Richard, 2006. *Overview of Current Conditions and Remediation and Restoration Considerations for Mount Haggin and Section 36 on Stucky Ridge.* Big Horn Environmental Sciences. July 2006.

Ueland, Don. Rocker Montana with Western Reclamation, phone cost quotations: 2006

FIGURES


Clear Creek
State Route 274
Mill Creek
Cabbage Gulch
Elk Creek
W Fork Willow Creek
Mt Haggin Injured Area Vegetation Map
Vegetation Cover
Vegetation Types
Bare
Bare greater than 35% slope
Forested - Conifer
Dense Shrub/Aspen Cover
Moderate Shrub/Aspen Cover With Scattered Conifers
Degraded Grassland
Degraded Grassland greater than 35% slope
N
Miles
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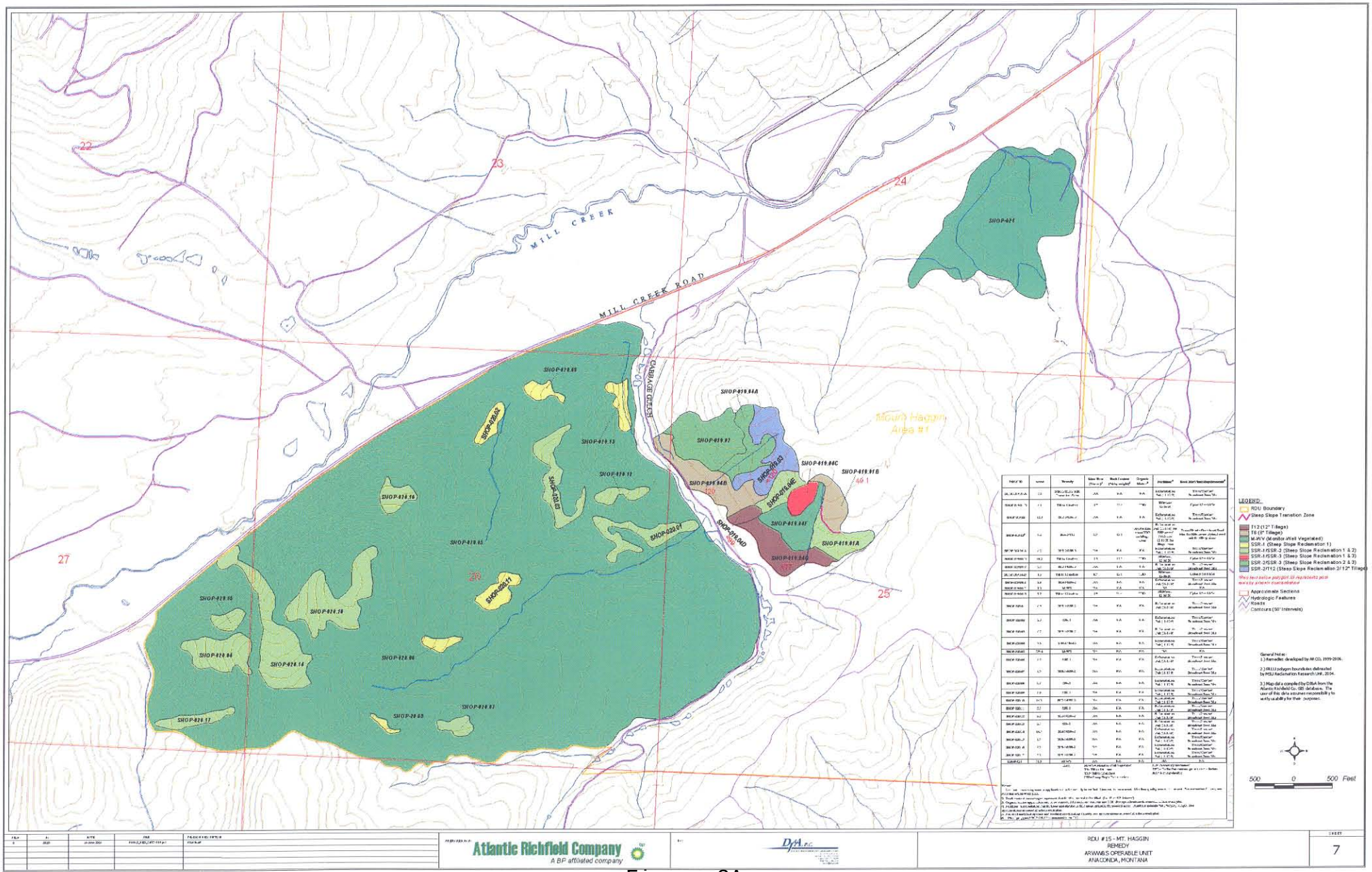
0.5
1
Mount Haggin WMA
Data Source: This map is based on 2005 1-meter resolution color infrared imagery and field sampling. Background imagery ouside of the study area is 2005 1-meter resolution natural color imagery. Roads are from the US Census Bureau's Tiger 1990 Highway layer. Streams are from National Hydrography Dataset.
Publication Date: July 2006
MONTANA
Natural Heritage Program

Figure 1


MILL CREEK
MILL CREEK ROAD
CABBAGE GULCH
Mount Haggin Area #1
SHOP-401
SHOP-819.84A
SHOP-819.84B
SHOP-819.84C
SHOP-819.84D
SHOP-819.84E
SHOP-819.84F
SHOP-819.84G
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SHOP-820.16
SHOP-820.17
22
23
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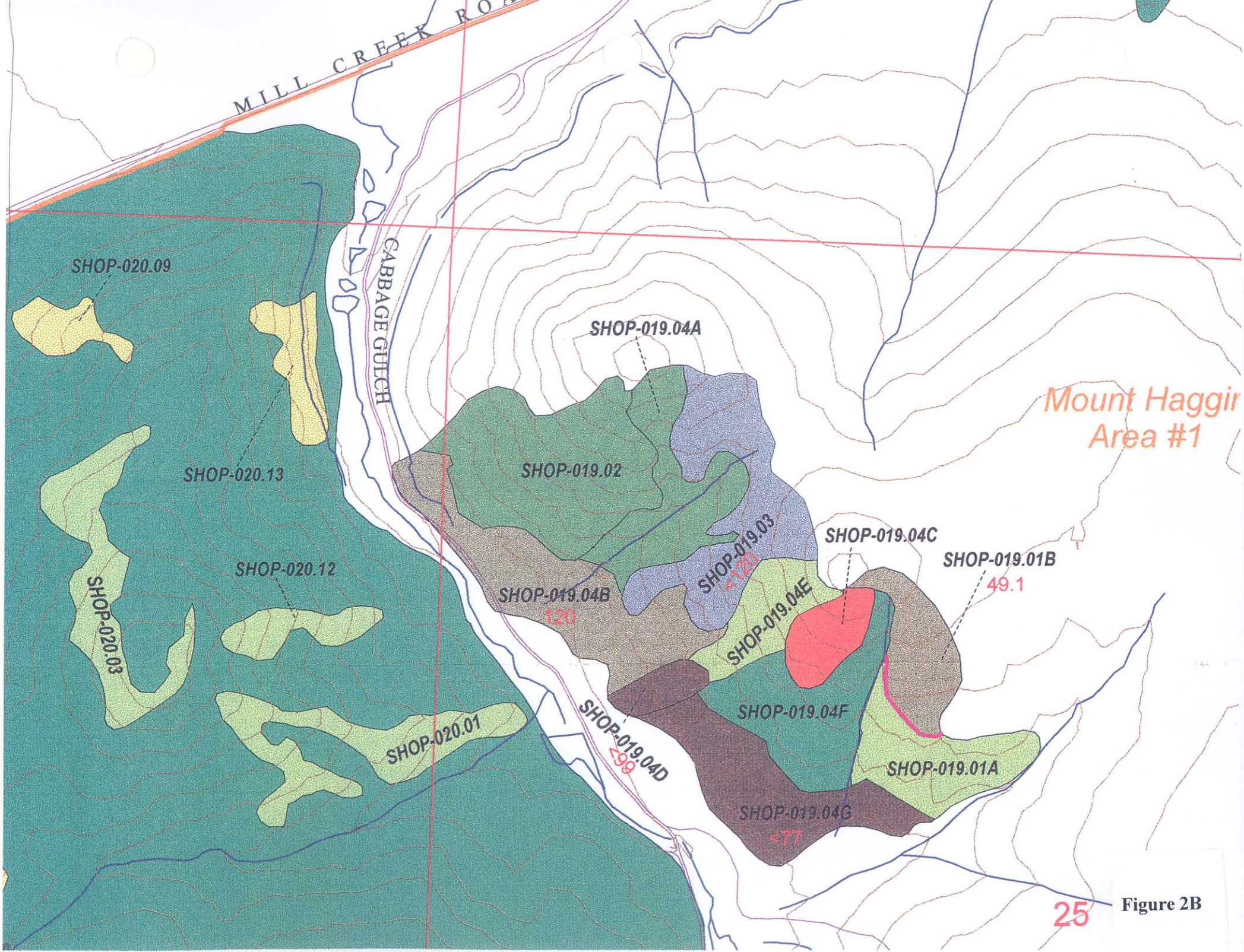
25
27
28
LEGEND:
RDU Boundary
Steep Slope Transition Zone
T12 (12" Tillage)
T6 (6" Tillage)
M-WV (Monitor-Wild Vegetated)
SSR-1 (Steep Slope Reclamation 1)
SSR-1/SSR-2 (Steep Slope Reclamation 1 & 2)
SSR-1/SSR-3 (Steep Slope Reclamation 1 & 3)
SSR-2/SSR-3 (Steep Slope Reclamation 2 & 3)
SSR-2/T12 (Steep Slope Reclamation 2/12" Tillage)
Approximate Sections
Hydrologic Features
Roads
Contours (50' Intervals)
500 0 500 Feet
Atlantic Richfield Company
A BP affiliated company
RDU #15 - MT. HAGGIN
REMEDY
ARWW&S OPERABLE UNIT
ANACONDA, MONTANA
7

Figure 2A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SHOP-019.04E
SHOP-019.04F
SHOP-019.04D
<99
SHOP-019.01A
SHOP-019.04G
<77
Mount Haggir
Area #1
25

Figure 2B

PRLU ID	Acres	Remedy	Lime Rate (T/acre)[1]	Rock Content (% by weight)[2]	Organic Matter[3]	Fertilizer[4]	Seed Mix/Plant Requirements[5]
SHOP-019.01-A	5.6	SSR-1/SSR-2 with Transition Zone	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-019.01-B	4.1	Till to 6 inches	2.7	22.4	TBD	500#/acre 12-16-30	Upland Seed Mix
SHOP-019.02	12.0	SSR-2/SSR-3	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-019.03[6]	9.2	SSR-2/T12	8.7	12.1	NA for SSR areas/TBD for tillage areas	Reforestation Pak (11-17-9) for SSR areas/ 500#/acre 12-16-30 for tillage areas	Trees/Shrubs/Broadcast Seed Mix for SSR areas/ Upland seed mix for tillage areas
SHOP-019.04-A	6.2	SSR-2/SSR-3	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-019.04-B	10.2	Till to 6 inches	5.3	15.3	TBD	500#/acre 12-16-30	Upland Seed Mix
SHOP-019.04-C	2.5	SSR-1/SSR-3	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-019.04-D	1.5	Till to 12 inches	8.7	12.1	TBD	500#/acre 12-16-30	Upland Seed Mix
SHOP-019.04-E	3.6	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-019.04-F	7.0	M-WV	NA	NA	NA	NA	NA
SHOP-019.04-G	7.7	Till to 12 inches	5.9	21.4	TBD	500#/acre 12-16-30	Upland Seed Mix
SHOP-020.01	6.5	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.02	2.3	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.03	6.7	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.04	7.5	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.05	575.4	M-WV	NA	NA	NA	NA	NA
SHOP-020.06	1.5	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.07	1.9	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.08	0.7	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.09	1.9	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.10	14.0	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.11	3.5	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.12	2.2	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.13	2.7	SSR-1	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.14	14.9	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.15	1.9	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.16	2.9	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-020.17	3.0	SSR-1/SSR-2	NA	NA	NA	Reforestation Pak (11-17-9)	Trees/Shrubs/ Broadcast Seed Mix
SHOP-021	56.5	M-WV	NA	NA	NA	NA	NA

Key:
M-WV= Monitor-Well Vegetated
T6= Till to 6 inches
T12= Till to 12 inches
SSR= Steep Slope Reclamation
PR= Previously Reclaimed
TBD= To Be Determined, prior to remediation.
NA= Not Applicable

Notes:
1. Lime rate shown represents application rate for remedy identified. Lime rate to be corrected for lime quality and rock content. For correction factors, see remedial action work plan.
2. Rock content percentages represent that for the interval to be tilled. (i.e. 6" or 12" interval)
3. Organic matter application rate to be corrected for moisture content and LOI. See specifications in remedial action work plan.
4. Fertilizer - Reforestation Pak for trees and shrubs in SSR areas, granular for seeded areas. Numbers indicate %N, $\%P_2O_5$, $\%K_2O$. See specifications in remedial action work plan.
5. For seed mix/plant species and seeding rate/planting density, see specifications in remedial action work plan.
6. 15% of polygon SHOP-019.03 is assumed to be T12.

LEGEND:
- RDU Boundary
- Steep Slope Transition Zone
- T12 (12" Tillage)
- T6 (6" Tillage)
- M-WV (Monitor-Well Vegetated)
- SSR-1 (Steep Slope Reclamation 1)
- SSR-1/SSR-2 (Steep Slope Reclamation 1 & 2)
- SSR-1/SSR-3 (Steep Slope Reclamation 1 & 3)
- SSR-2/SSR-3 (Steep Slope Reclamation 2 & 3)
- SSR-2/T12 (Steep Slope Reclamation 2/ 12" Tillage)

Red text below polygon ID represents post remedy arsenic concentration

- Approximate Sections
- Hydrologic Features
- Roads
- Contours (50' Intervals)

General Notes:
1.) Remedies developed by ARCO, 1999-2006.

2.) PRLU polygon boundaries delineated by MSU Reclamation Research Unit, 2004.

3.) Map data compiled by DJ&A from the Atlantic Richfield Co. GIS database. The user of this data assumes responsibility to verify usability for their purposes.

N W E S

500 0 500 Feet

RDU #15 - MT. HAGGIN
REMEDY
ARWW&S OPERABLE UNIT
ANACONDA, MONTANA

Legend on Figure 2A

SHEET
7

LEGEND

RAWP Boundary

Steep Slope Transition Zones

201.0 (Arsenic dilution concentration (mg/kg))

Test Pit Locations

NCA13 (Sample Point ID)

PRLU Polygon Remedy

- T12 (12" Tillage)
- T6 (6" Tillage)
- SSR-1(Steep Slope Reclamation #1)
- SSR-1/SSR-2 (Steep Slope Reclamation #1 & #2)
- SSR-2/SSR-3 (Steep Slope Reclamation #2 & #3)
- SSR-4 (Steep Slope Reclamation #4)
- M-WV (Monitor-Well Vegetated)
- M-WV/T6 (Monitor-Well Vegetated/ 6" Tillage)
- M-WV/T12 (Monitor-Well Vegetated/12" Tillage)
- PR (Previously Reclaimed)
- Tillage Demo
- Rock or Facility

Railroad Tracks

Roads

Hydrologic Features

Contours (50' Intervals)

Approximate Section Line

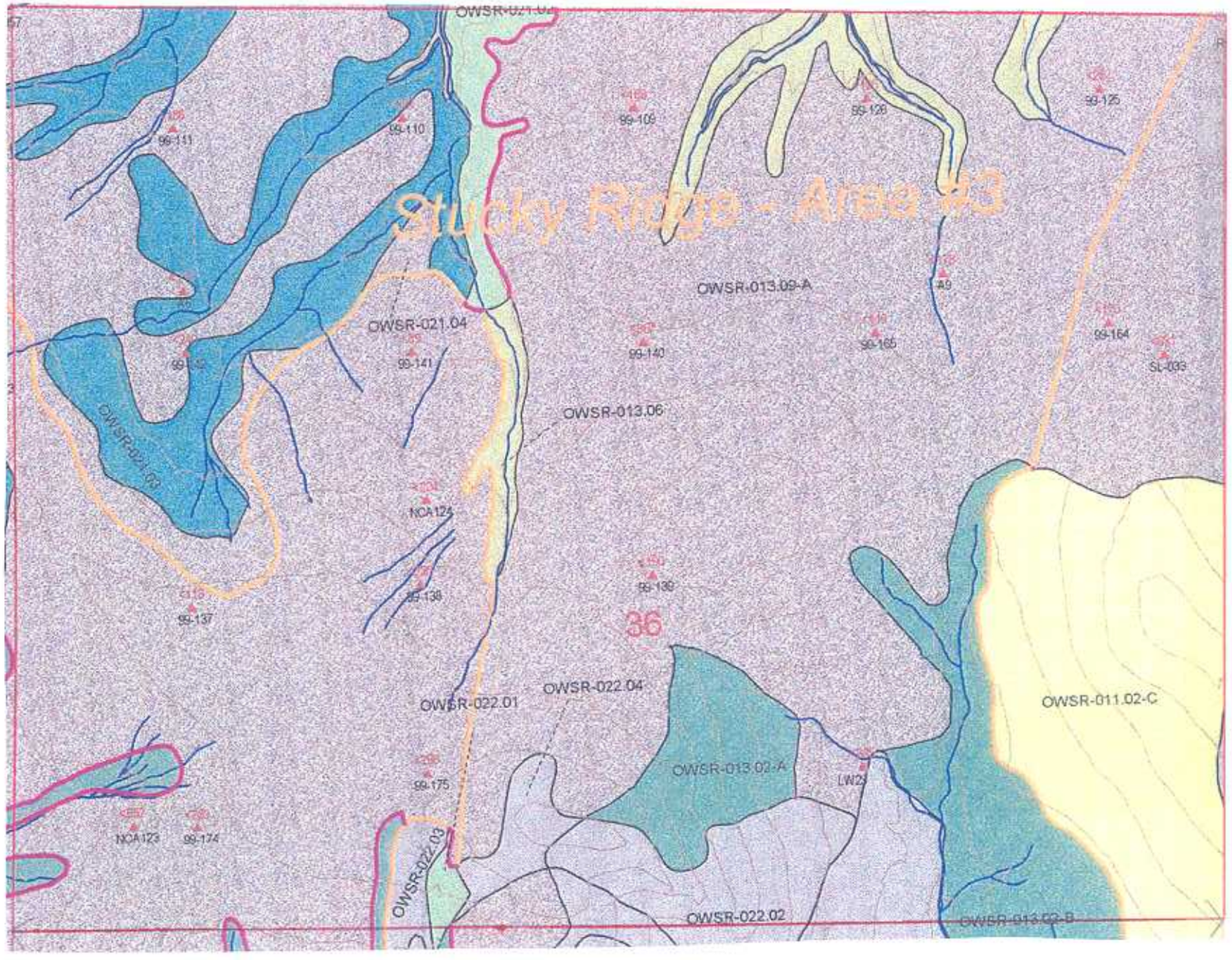

Figure 3
State Owned Section 36 on Stucky Ridge.

APPENDIX A
PHOTOGRAPHS OF MOUNT HAGGIN UPLANDS

(Photo descriptions by Rich Prodgers
with Bighorn Environmental Sciences)

Figure A1. The Mount Haggin Game Range was variably affected by smelter emissions. Some sites first lost plants, then topsoil, and now are undergoing primary succession – a slow process within the context of human expectations. At other areas, vegetational development was initiated before soil resources eroded away. While species composition is far from pristine and some functions remain impaired, portions have a satisfactory amount of plant cover.

Figure A2. The granitic material is extremely erosive, and many sites are unstable and actively eroding. Part of remediation will require engineered erosion control measures in addition to extensive revegetation.

Figure A3. Natural plant succession? More like the unnatural succession of noxious weeds. This unstable gully at Cabbage Gulch has three weeds (whitetop, leafy spurge, and knapweed) and no natives worth mentioning.

Figure A4. Revegetation of Cabbage Gulch would be easier if this raw, eroding hillside was being colonized by native plants that contribute to wildlife habitat rather than leafy spurge. Some would say that even leafy spurge is better than nothing, but it is not effectively stabilizing this slope.

Figure A5. Ground surface contamination conferred on plants that spread vegetatively belowground (e.g., from rootstocks and rhizomes) a reproductive advantage over seeds germinating in the most contaminated near-surface zone. Top photo reveals mostly redtop, an introduced, naturalized, unpalatable grass. Lower photo shows small leafy spurge plants on a droughty granitic susbtrate that was otherwise uncolonized since denudation. Raising near-surface pH is a major goal of remediation, one that will greatly promote revegetation.

Figure A6. The list of subterranean reproducers is a long one, including graminoids (Baltic rush, upper photo, typically found in depressions and rarely on slopes such as this one), forbs (Canada thistle, leafy spurge in lower photo amidst knapweed), shrubs (snowberry, chokecherry), and deciduous trees (aspen).

Figure A7. Two more attractive, native examples of vegetative plant reproduction in contaminated areas of the game range are creeping barberry (upper photo, seed commercially available) and starry false Solomon's seal, perhaps most at home in the shade but occasionally found in full sunlight.

Figure A8. Whitetop, one of the prevalent noxious weeds at Cabbage Gulch, is another species with extensive rootstocks. (I took this one home to photograph.) It is extremely difficult to control, but it doesn't tolerate the most droughty sites, as does leafy spurge in Figure A4. Most areas requiring remediation and restoration are presently weed-free or nearly so.

Figure A9. The remains of a decadent stand of antelope bitterbrush remains at Cabbage Gulch (upper photo on distant slope). While some shrubs still are browsed, they have low vigor and abundance. Meanwhile, natives failed to colonize this site. Instead, a collection of noxious weeds has filled the voids (lower photograph).

Figure A10. Upper photo shows the appearance of one of the healthier bitterbrush shrubs at Cabbage Gulch. For contrast, lower photo shows the same species at a roadcut in granitic material near the base of the East Ridge next to I-90. This stand too has knapweed. Bitterbrush is usually a pioneer species.

Figure A11. Pines (limber pine in this case) don't reproduce from root parts, but they may have an extensive lateral root system, especially where other plants are few and they can secure resources near the ground surface.

Figure A12. Redosier dogwood is completely off-site on this convex hillslope. Its water requirements are met by large root mass and few competitors, the result of a near-surface soil contamination.

Figure A13. Some remaining plants are relicts that survived smelter fumigations and soil contamination. Their degree of spread has been slight due largely to remaining contaminants and acidity. (Pictured here are Rocky Mountain juniper and Scouler willow.) One of our goals is to jump-start vegetational development through site improvement and innovative revegetation.

Figure A14. The rocky slope (upper photo) affords some opportunity for effective broadcast seeding if "soil" pH can be brought to neutrality and fertility is adequate or improved. Smooth slopes present greater challenges – some sort of mechanical amendment incorporation and seedbed preparation would greatly promote seeding success. Erosion control structures are also desirable and may create favorable microsites for transplants.

Figure A15. A tough revegetation challenge such as the Anaconda Uplands warrants a humble approach – including trying out ideas on a small scale before committing to expensive experiments. We created some test plots to see how various treatments (including liming and fertilizing) and seed mixes and methods (broadcasting with and without raking) would do. These would best be evaluated in 2007. (Location is just below the crest of the slope in lower Figure A12.)

APPENDIX B
PHOTOGRAPHS OF STUCKY RIDGE

Figure B1. The eastern edge of unremediated Section 36 and the western boundary of remediated Stucky Ridge Area 4 (OWSR-013.09) in Section 31 are clearly visible. Aside from having whiter soil, the remediated area has more plant cover, but not perhaps as much as was hoped. The modified NRD plan has several reclamation and revegetation strategies designed to improve revegetation.

Figure B2. The 480-acre state-owned portion of Section 36 is predominantly barren, especially the eastern half. The zone of coarse sediment accumulation in the lower photograph is virtually devoid of plants.

Figure B3. In addition to noxious weeds, gray horsebrush is one of the most common plants in Section 36. However, regeneration is nil and many of the old plants are dead.

Figure B4. The western half of Section 36 is the most eroded part, but at the same time it has more vestiges of native vegetation, including basin wildrye and aspen – even a nice patch of narrowleaf willow. While meager, increased plant survival in the west probably is related to lesser contamination (upwind from old smelter), whereas erosion is linked to substrate characteristics.

Figure B5. A few patches of chokecherry in western Section 36 indicate better conditions for plant growth than nearer the old smelter. Reliance on underground reproduction (in contrast to seed establishing new plants near the ground surface) is characteristic of areas with surficial contamination but better rooting habitat below.

Figure B6. This fine basin wildrye revegetation in Section 35 could indicate (relative to Section 31 revegetation) a less contaminated site, a better plan, better implementation, or luck. The presence of patches of native plants (dogbane in lower photo) suggests that the level of contamination is less inimical to plant growth here. (Lower photo also shows that grasses are not necessarily best-suited to very coarse substrates.)

Figure B7. This steep, rather smooth slope in Section 36 will be a revegetation challenge. Probably a terrace and dozer basins will be necessary to lessen slope length and erosion. Note the fresh sediment deposit in the drainage bottom.

Figure B8. Satisfactory revegetation of the foreground-midground is likely following the NRD plan. The steep, rocky hill in the background is a tougher challenge – if it won't grow weeds, growing anything will be difficult, and mechanized options are limited.

Figure B9. Herbicide application in Section 36 was generally effective, but remnants of Canada thistle (upper photo) and leafy spurge (lower photo) are sprouting. Effective weed control is the first element of successful revegetation implementation. (See B16.)

Figure B10. In Section 36, possible improvements on Section 31 remedy may include limited removal to onsite repository, growing a preparatory crop while lime equilibrates and the seedbed firms, fertilizing to complement inherent substrate nutrient levels, use of adapted species such as Copperhead slender wheatgrass and an unnamed bluegrass developed from local, metal-adapted genotypes, and planting light- and heavy-seeded species separately using different techniques.

Figure B11. The most plausible explanations for limited revegetation success in Section 31 are poor seeding conditions and excessive heavy metal concentrations even at neutral to slightly basic pH. The Bridger Plant Material test plots were seeded with a firm seedbed, so we suspect that metal/metalloid concentrations in some areas are simply too high for acceptable plant growth.

Figure B12. NRD sees additional options for slope revegetation, including lime incorporation, furrows, dozer basins, and seeding species adapted to rocky soils – typically shrubs and forbs.

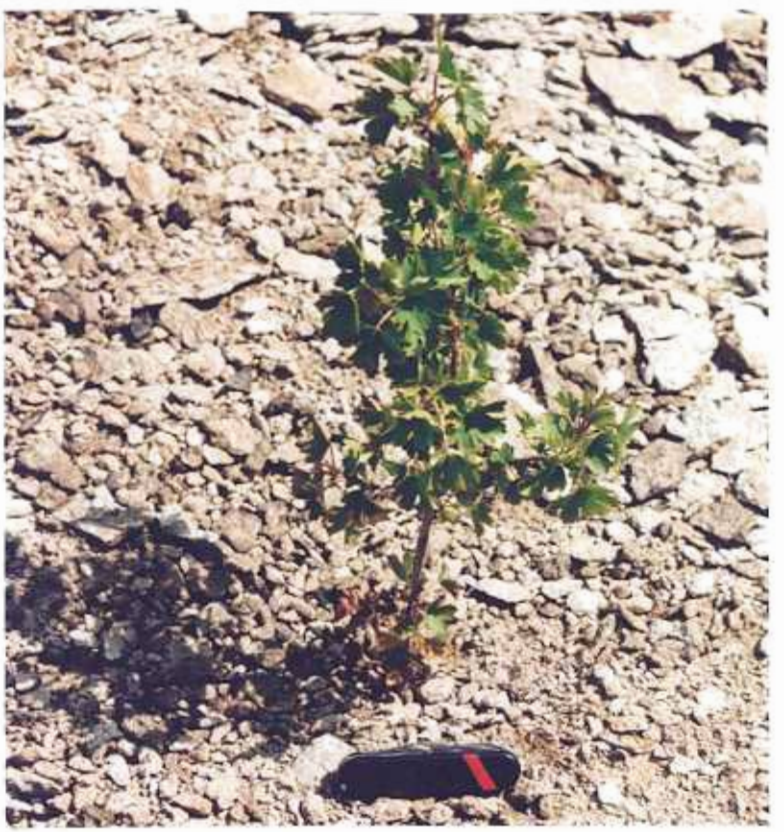

Figure B13. Golden currant, transplanted in Section 31, can be effectively established from seed where plant competition is not too great. This shrub species requires a better soil moisture regime than Stucky Ridge uplands – unless it can "harvest" water from a rather large area. The same is true of conifers.

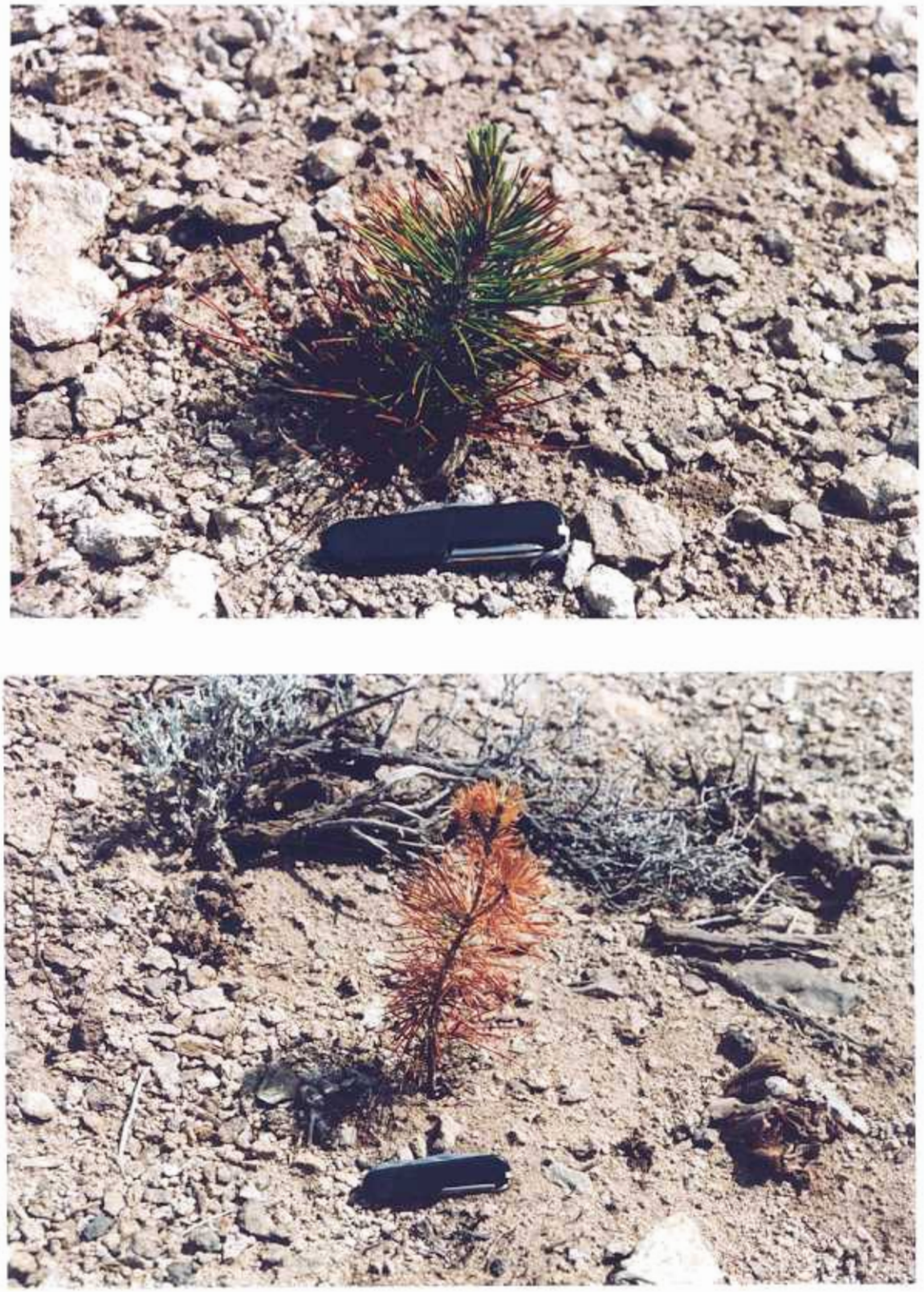

Figure B14. Some of the transplanted conifers in Section 31 survived while others did not. Transplanting right after seeding isn't necessary and can conflict with interseeding, if necessary. After herbaceous cover is established, transplants can be placed in the most promising, unoccupied microsites, a process of "prospecting" for transplant locations.

Figure B15. Plant establishment in Section 31 dozer basins is largely restricted to scalloped areas, suggesting that removal of the contaminated layer was key. NRD proposes liming slopes as well as gentler areas.

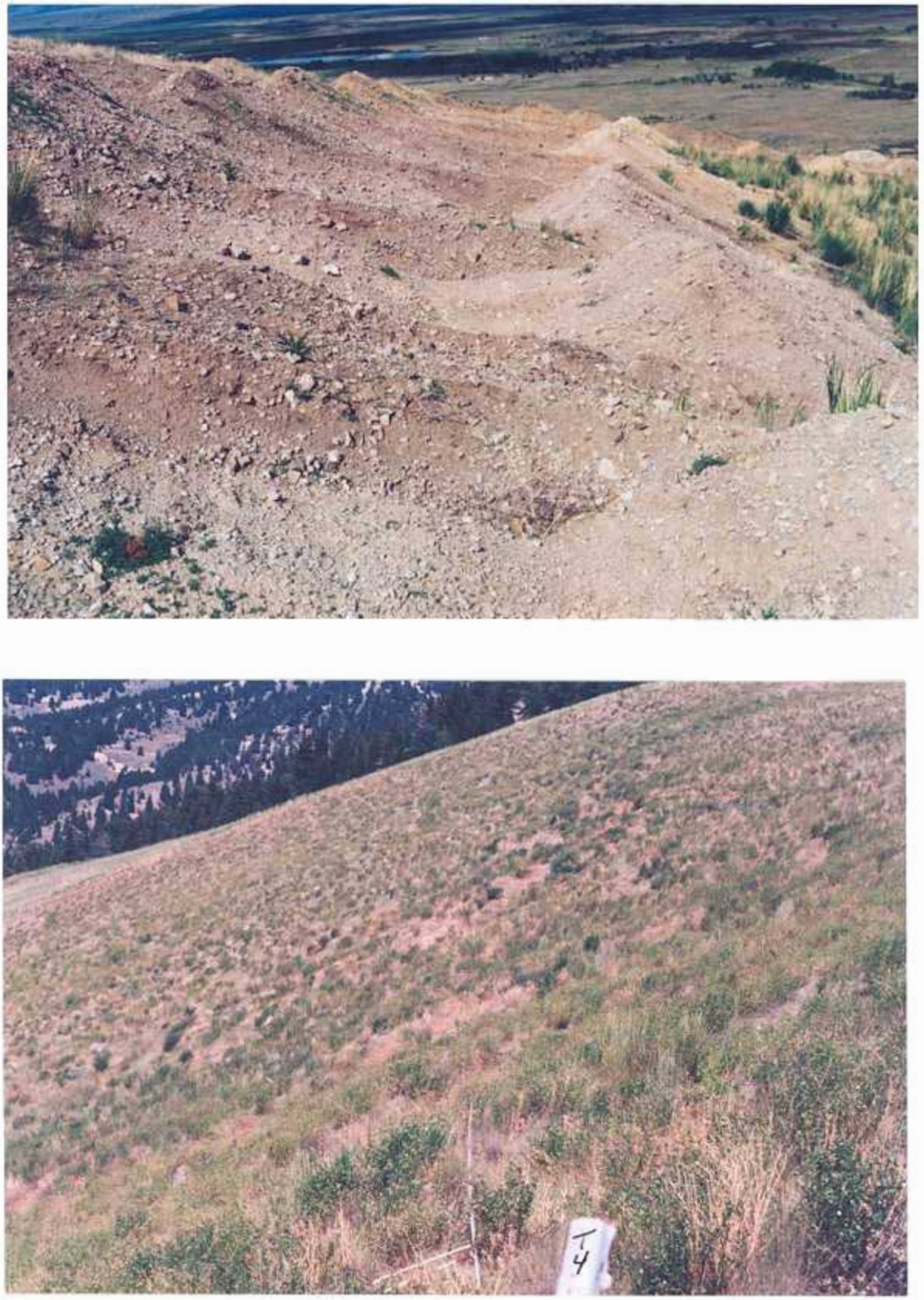

Figure B16. Treated areas need not look like a bombing range. Lower photograph is a 50% slope at the Golden Sunlight Mine constructed in 1992 and photographed in 2004. This hillside has hundreds of dozer basins that are not conspicuous from a distance.

Figure B17. Aggressive dozer basins also leave an over-steepened outer slope that is very difficult to revegetate and contributes to erosion. Hand-seeding can help, but basins should blend into the landscape after a few years.

Figure B18. Lack of adequate prophylactic noxious weed control can lead to a later epidemic (green foliage beyond dead willows). Already this is beyond effective control via backpack spraying of herbicides.

APPENDIX C

1) *Overview of current conditions and remediation and restoration considerations for Mount Haggin; Current condition of impaired vegetation and adjacent revegetation at Stucky Ridge; Remediation and restoration considerations for Section 36 on Stucky Ridge*. Report by Richard Prodgers with Bighorn Environmental Sciences Inc. (15 pages)

2) Mount Haggin Injured Area Vegetation Map Report by Dr Greg Kudray with the Montana Natural Heritage Program (2 pages)

3) Seed mixes for Stucky Ridge and Mount Haggin by Richard Prodgers (2 pages)

4) Materials Quantity table for the Area 4 work on Stucky Ridge (adjacent to Section 36) by Arco in 2002.

OVERVIEW: CURRENT CONDITION OF MOUNT HAGGIN VEGETATION

To the casual observer, vegetation of the affected Mount Haggin Game Range area falls for the most part into two discrete categories: predominantly barren/obviously impaired areas and the rest, which appears generally unaffected. Virtually all of the slopes and most drainage bottoms have been injured from metals. The visual distinction is that of:

1) areas that partially "recovered" before fundamental site degradation ensued, and
2) sites that lost some soil and exhibit a greater degree of impairment.

The speed at which the recovery process has and is proceeding differs greatly among these two site types. On barren slopes and hilltops, mostly upper-slope warm-aspect sites, revegetation requires initiating or augmenting primary succession. In their current condition, these sites will not support a preimpact level of plant cover and production. Vegetational development is proceeding very slowly, sometimes only on the most favorable microsites. The restoration goal is to accomplish in years what would otherwise take decades or centuries.

In conjunction with widespread site amelioration and seeding, creating more favorable microsites can play a role in restoration on barren slopes. Natural barriers to erosion, such as logs naturally anchored on steep slopes, have accumulated sediments that provide a better plant-growth medium than adjacent areas. Staking more logs, wattles and other best management practices (BMP's) in place after seeding can promote at least pockets of revegetation that either spread or provide a source of continuing propagule dissemination. However, mechanical treatments that incorporate amendments and place seed below the surface offer the potential for much greater improvement and more rapid recovery where feasible.

At the other end of the spectrum, many cool-aspect slopes and some drainage bottoms are well-vegetated with adapted species, some of them native (e.g., aspen) and others introduced/naturalized (e.g., redtop, *Agrostis stolonifera*). Here, seminatural recovery (including introduced species) ensued before the soil ran into the drainages. Remediation/restoration are not planned for these Aspen areas.

In satisfactorily vegetated areas, the prevalence of species that reproduce from underground parts (rhizomes, rootstocks) is striking. It suggests that the contaminated soil surface is unfavorable to reproduction from seed, but that vegetative reproduction from plant parts spread throughout the subsoil is a successful strategy. With the exception of conifers, 90% or more of the existing plant cover originates with plants practicing vegetative reproduction. Table 1 lists some plant species in impacted areas and their usual mode of reproduction. Apart from spotted knapweed and pines, very little reproduction occurs among species in the seed reproduction column.

REMEDIATION AND RESTORATION CONSIDERATIONS for MOUNT HAGGIN

In planning revegetation, observations from the Mount Haggin injured area will guide restoration efforts. Below are considerations which will be followed during restoration implementation.

- The prevalence of subterranean reproduction indicates that surface acidity/metal concentrations severely limit reproduction from seed; yet seeding is the key to effective revegetation. Liming must be considered a critical element of revegetation of both severely and partially impaired sites.

- Where lime can be physically incorporated into acidic substrate, one winter-spring will be required for the lime to react usefully with soil fines and rock fragment surfaces.
- Where lime cannot be incorporated, at least two years should be allowed for equilibration in the substrate matrix, assuming the lime stays where applied. The potential exists for a downpour to erode the lime layer just as erosion has removed the original soil. Some steep slopes may require a second liming.

Table 1. Reproductive Strategies of Upland Plant Species of the Mount Haggin Affected Area.

SUBTERRANEAN REPRODUCTION	RELICTS – SEED REPRODUCTION
Grasses & Grasslike	
Kentucky bluegrass (lower slopes, int.)	Slender wheatgrass (lower slopes)
Elk sedge (prev. conf. understory)	Bluebunch wheatgrass (upper slopes)
Redtop (a.k.a. bentgrass, introduced, ubiquitous)	
Baltic rush (limited distribution)	
Forbs	
Creeping Oregon grape (*Berberis repens*)	Spotted knapweed (no relict, int. noxious weed, Cabbage Gulch)
Solidago missouriensis	
Aster (no flws., probl. *A. ascendens*)	
Canada thistle (introduced weed)	
Penstemon procerus (few, insignif.)	
Grouse whortleberry (prev. conf. understory)	
Leafy spurge (int. noxious weed, Cabbage Gulch area)	
Whitetop ((int. noxious weed, Cabbage Gulch area)	
Shrubs	
Snowberry (*S. albus*, lower slope)	Common juniper
Chokecherry	Willow (*S. scouleriana*)
Alder	Russet buffaloberry
Chokecherry (could be relicts too)	Serviceberry
Trees	
Aspen	Pines – tolerate pH 4, reproducing

- The prevalence of subterranean reproducers also suggests that revegetation should feature them whenever possible should liming be ineffective. Unfortunately, the limited availability of commercial seed of desired species and appropriate plant hardiness (portions of Zone 3, elevational range 5,500-7,500 feet) constrains the choice of site-adapted rhizomatous species, and many nonrhizomatous species also must be seeded.
- The most impaired sites have steep, warm-aspect slopes. Soils on these sites were probably skeletal initially, and erosion loss quickly followed denudation, impairing these substrates fundamentally. In addition to acidity and contaminants, revegetation of the worst sites must address extremely coarse, droughty, infertile substrates with little if any organic matter and lacking a functioning soil foodweb. Nitrogen fixation is very desirable.
- Conifers have invaded some sites, one of the few growth-forms able to do so from seed. Yet they have been unable to effectively colonize the site type just described. It is unlikely that conifer planting will be an appropriate strategy on all steep, eroded, warm-aspect slopes where several consecutive years of favorable precipitation may be required for survival. Drought tolerant shrubs may be more appropriate in such areas.
- Although annual precipitation ranges from about 15 inches to more than 20 inches, the most severely impacted sites should be planted with drought-tolerant species suited to coarse substrates in drier precipitation regimes. Drought-tolerance and vegetative reproduction (discussed above) are desired traits for this type of revegetation.

- Where tough sites have been colonized, whether by native (e.g., *Aster ascendens* based upon vegetative identification) or introduced species (e.g., leafy spurge and whitetop north of Cabbage Gulch), plant production, which is tied directly to recovery, is severely limited by low water- and nutrient-holding capacity. While these limits cannot be overcome directly to the extent desired, restoration can improve fertility enough to accelerate the recovery process.
- Due to the low cation-exchange capacity of residual granitic substrates, several incremental fertilizations will promote better and more permanent plant growth than a single heavy dose of fertilizer, which may rinse through the substrate or off the site.
- Coarse, droughty sites are often better-suited to forbs and shrubs than to grasses. This too can guide the selection of revegetation candidates. In very coarse, skeletal substrates, seed should be placed deeper than in heavier soils (i.e. more clayey), especially when using heavy-seeded species (fewer than roughly 300,000 seeds/pound). A retractable steel rod harrow is suggested for use in these areas. If seed cannot be planted due to steepness, just tossed on the surface, light-seeded species are more successful. Often this type of seed is much more expensive than the most popular revegetation species, such as wheatgrasses (around 150,000 seeds/pound). Some desirable shrubs have very heavy seed (e.g., antelope bitterbrush, 15,000 seeds/pound, but others are light.
- The more limiting the site for revegetation, the more likely failure becomes. For example, coarse substrates can dry so quickly following seed germination that entire crops of tiny seedlings are wiped out. The revegetation plan and budget provides for two or three seedings and spread transplanting among several years.

- Construct erosion barriers on steep, predominantly barren slopes using wattles, staked logs, and dozer basins. These may be used as shrub transplant microsites.
- Where augmenting natural recovery, the Montana Department of Fish, Wildlife and Parks prefers not to destroy too many existing native plants, e.g., through deep tilling. This has merits but can pose additional seedbed preparation and seeding challenges.
- An abundance of noxious weeds poses a conundrum for revegetation. Successful revegetation cannot occur without thorough weed control, but weed control cannot succeed without revegetation. It is entirely possible to exchange one weed or set of weeds for other weeds even less desirable and more difficult to control. In the presence of noxious weeds, any remediation action that improves site conditions will promote established weeds more than freshly seeded or planted species. The phenomenal weedy seedbank on the north side of Cabbage Gulch presents another challenge, that of copious weeds germinating with planted seeds. Special efforts will be taken to avoid damaging existing bitterbrush plants. The most promising strategy for many noxious weeds is fall herbicide application, which minimizes damage to non-target plant species. Whitetop requires spring application with a specific herbicide that is unsuitable for most other noxious weeds. Depending upon revegetation success, subsequent backpack spraying of individual plants may allow seeded plants to get off to a good start. However, contractors capable of effective backpack spraying are not always available.

OVERVIEW: CURRENT CONDITION OF IMPAIRED VEGETATION AND ADJACENT REVEGETATION AT STUCKY RIDGE

Impaired Vegetation Section 36

The northern three-quarters of section 36, which is State owned lands, in Stucky Ridge will be remediated with additional restoration components. Existing vegetation is severely degraded and mostly irrelevant to revegetation. Relicts comprise dead/decadent horsebrush, the most prevalent type, with a few areas of basin wildrye. The most common weed is Canada thistle, but whitetop, leafy spurge, and spotted knapweed are present and common in some areas. It is clear that the effectiveness of past chemical weed control is waning. The best vegetation is some aspen and in one place narrowleaf willow that are generally confined to drainages in the west; satisfactory vegetation will be preserved to the extent possible. Area-wide average plant cover is on the order of 5%-10%. Gullies up to two meters deep are most common in the western portion toward the head of drainages.

The effectiveness of adjacent reclamation/revegetation efforts is pertinent to restoration planning. East of the State section, Section 31, Stucky Ridge Area 4, also known as the 2002 demonstration area, has patchy but generally mediocre revegetation. West of the State section, Section 35, was revegetated earlier and much more successfully. The fact that Section 35 is upwind of the old stack and Section 31 is downwind is probably significant: the upwind area has more successful revegetation.

Remedial design for Stucky Ridge indicates the following treatments for designated portions of Section 36. These treatments are outlined in detail in Appendix E.

- 335 acres of T12 (Tillage to 12 inches)
- 40 acres of SSR1 (Steep Slope Reclamation, type 1)

- 35 acres of well vegetated (areas where no revegetation is required)
- 30 acres of SSR2/3 (Steep slope reclamation, type 3)
- 20 acres of SSR 4 (Steep slope reclamation, type 4)
- 20 acres of rock

This plan will perform remedy on these 480 acres as outlined in the Remedial work plans, see appendix E[1]. However, some modifications of the remedy designs for this area will be made such as seed used and timing of reclamation activities.

Adjacent Revegetation Remediated in2002:

An area of about 200 acres to the east of Section 36, Stucky Ridge Area 4, was remediated in 2002 and 2003, (see Appendix C which contains maps of this area). The most prevalent treatments in this upland area was to lime at 22 tons/acre and deep till (three to five passes) to approximately 12" to incorporate the lime and dilute metals/metalloids that were most concentrated near the surface. Reducing arsenic concentrations was a particular objective. A rather heavy fertilization of 500 pounds/acre of 12-16-30 was applied. About 8.5 acres were mulched.

The area was drill-seeded in May 2003 at 25 pounds PLS per acre (a heavy application) with another 10 pounds of barley. (Nurse crops are often harmful to desired perennials, especially in dry years; they are justified where the erosion risk is severe.) The seed mix might be characterized agricultural – four species of wheatgrass, basin wildrye, Indian ricegrass, and two light-seeded grasses: sheep fescue (introduced) and big bluegrass. Of these, the grasses adapted to acid/metalliferous substrates were sheep fescue and to a

[1] Appendix e contains parts of the January 2005 Final Stucky Ridge Design Report by Atlantic Richfield Company. The Stucky Ridge area is divided in four parts called Areas One-Four. Area 3 covers the majority of Section 36, however, parts of Section 36 are in Areas 2 and 4.

lesser extent basin wildrye, big bluegrass, and slender wheatgrass. These were also the most successful species.

Small amounts of blue flax, fringed sagewort, and common yarrow were included in the seed mix. These commonly used forbs are fine establishers. Yarrow is very widely adapted and might be expected to work even in areas of moderate contamination as it has along Silver Bow Creek. The fact Yarrow and the other forbs are essentially absent suggests either that drill seeding placed light seed too deep to establish, or that strong, persistent herbicide applications killed or prevented forbs from establishing. Since sheep fescue (light seed) is common and blue flax has borderline light/heavy seed, it is possible that herbicides conflicted with non-grass revegetation. Section 36 was sprayed with Tordon and Cimmeron in June 2005, and a similar treatment to Area 4, would explain the lack of forbs. At heavy application rates, these herbicides can also be harmful to establishing grasses.

Some portions of the tilled areas were reseeded. The main reseeded area was a band running from southwest to northeast along the ridge, particularly the southeast-facing slope. The other area might be termed the central part of the tilled area. Except for some patches, neither were satisfactorily vegetated in 2006.

Possible Causes of Unsatisfactory Revegetation in Area 4 of Stucky Ridge

Some site factors can be ruled out as causes of impaired revegetation in Subarea 4. Texture of three samples taken in 2006 were all sandy loams with 18-19% clay. This is nearly optimal for revegetation. The amount of coarse fragments was not measured, but it was not excessive except at rock outcrops near the ridge. The lower slope contains more cobbles than midslope but has some of the better revegetation.

Fertility is another factor that is not suspect. The few samples obtained indicated that P and K were sufficient and that plant availability of those macronutrients was unaffected by fertilization because it was already adequate. Nitrate concentrations of 6-9 ppm and ammonium levels one-third of those are adequate in early spring with plants growing. While lack of nutrient cycling will impair vegetational development, infertility didn't limit establishment or plant performance so far.

The lack of vegetation outside the basins in steep-slope areas indicates that just building dozer basins without liming (and otherwise amending as needed) and incorporating leaves about half of the slopes unvegetated. This is unsatisfactory. Future erosion, both natural to the slope and accelerated by over-steepening related to the dozer basins, will fill basins with contaminated soil, further reducing the amount of satisfactory revegetation. Dense patches of noxious weeds are present, especially on the east-facing slope, but no corrective action is evident.

The following points below summarize possible causes of patchy or unsatisfactory revegetation in the area adjacent to Section 36, realizing that more than one factor may be limiting and interactions are likely:

- Even at neutral to slightly basic pH, heavy metal concentrations in may have impaired revegetation. This correlates with the observation that reclamation was more successful to the west (Section 35). It also correlates with observations (J. Bensen and M. Majurus, pers. comm.) that initial germination promised many more plants than lived to establish, and that the trend on these sites has been downward. Metal impairment need only impair root development, for example, for young plants to succumb during the first dry period. Drought is exacerbated by a fluffy seedbed.

Arguably the most metal-tolerant grasses are the most prevalent, and all locally successful grasses exhibit a useful degree of metal tolerance. If the most contaminated spots could be mapped, limited removal or stripping (possibly to an onsite repository) might be practical.

- Uniform liming and incorporation on a variably contaminated substrate may have left areas of low pH where metals were insufficiently immobilized or residual acidity directly impaired revegetation. However, our composite sampling of upper coversoil at one good and two predominantly barren spots revealed that pH is about the same, between pH 7 and 8.
- Insufficient time may have elapsed between liming and seeding for lime to equilibrate in the coversoil matrix. This is speculative, but a fresh, dry mix of lime and contaminated dirt may not immobilize metals as well as after several wetting fronts have passed through the coversoil with the soil solution mixing chemicals and neutralizing pH at a micro-scale.
- Seeding implementation is another possible cause of poor/patchy revegetation. A sandy loam is a "light" soil. No doubt three to four (up to five) deep discings left an excessively fluffy seedbed unsuitable for drill seeding. Waiting until the following spring to seed was a good practice, although since tillage was completed 11/14/02, it may have been more necessity than preference. Three years following seeding, the ground surface is barely firm in many places. However, at least portions have been seeded a second or third time, which means that portions received 50-75 pounds of seed/acre. Also, the Bridger Plant Material test plots were well seeded with a firm seedbed (M. Majurus pers. comm.), and they fared no better than nearby areas seeded

by Western Reclamation. Thus, we are persuaded that seeding implementation was probably a contributing rather than a primary factor. Improvements in seeding practice as well as seed mix are both desirable and possible, however.

- Herbicide application may have conflicted with plant establishment, especially forbs. The three most likely reasons for unsatisfactory revegetation in area 4 are: 1) levels of contaminants that impair revegetation, especially from seed, even at neutral to slightly basic pH; 2) poor seeding implementation due to a fluffy seedbed resulting from numerous tillings while dry and seeding into same; and 3) not allowing the lime to equilibrate in the coversoil matrix before seeding.

REMEDIATION and RESTORATION CONSIDERATIONS for SECTION 36:

Depending upon final characterization of substrates, specific options for remedy/restoration of Section 36 are proposed below. These actions will be done in combination with methods proposed for remedy in the remedial design report (Appendix E).

- Limited removal/consolidation of upper severely contaminated strata before contaminants are mixed throughout the primary root zone. This practice is known as stripping.
- One-time fertilization may be critical, but it does not initiate effective nutrient cycling. A good organic amendment is best, but if for some reason impractical a slow-release fertilizer or several light applications of conventional mineral N fertilizer is better than a single heavy application. Seed mix composition and application rate should be based upon coversoil analysis following lime incorporation.

- Either tailor the liming rate to the level of contaminants or increase the 22 tons per acre liming rate by a safety margin throughout. The limitations of "over-liming" are small relative to inadequate pH melioration and metal immobilization.
- Initial seedbed conditions are likely to be unfavorable following multiple tillings and the lime/dirt matrix will not have equilibrated chemically. Plant an annual cereal grain (e.g., cereal rye) as a preparatory crop.
- Implement weed control measures two years prior to initiating remediation.
- If the preparatory crop reveals a pattern of plant abundance unrelated to physical substrate characteristics, sample the coversoil in areas of poor establishment and further remediate as necessary.
- Prior to remediation, there may be a role for strong, persistent herbicides such as Tordon for most weeds and Cimarron for whitetop (and also Canada thistle). Alternatively, more targeted application may be effective. In any case, once the final ground surface is in place, target application (as opposed to blanket application) of more selective herbicides is more conjunct with revegetation. For example, in established revegetation along Silver Bow Creek, a mix of Curtail (or Milestone could be used), 2,4-D ester, and Escort is spot applied to knapweed, tall pepperweed, whitetop, leafy spurge, Canada thistle, and absinth wormwood. This regime has been effective while leaving revegetation unharmed.
- Permanent seeding technique must be based on seedbed conditions, which cannot be predicted. Seedbed conditions may have to be improved by additional treatment or by delaying the permanent seeding until conditions are acceptable.

- Include at least four adapted species in the seed mix, representing a variety of growth-forms. Two new releases from the Bridger Plant Material Center are promising for Stucky Ridge: Copperhead slender wheatgrass and a new but presently unnamed variety of big bluegrass. Two standard cultivars that must be included are Trailhead basin wildrye and Covar sheep fescue.
- Seedbed conditions dictate seeding method.
- Weather always plays a role in the plant establishment dynamic, and additional lessons are learned from experience. Reclaiming Section 36 in two phases one or two years apart would spread the risks and allow the use of knowledge gleaned from the first area to be applied in the second. In this scenario the upslope area would be reclaimed first.
- Where possible, steep slopes should be limed, then fertilized based on substrate fertility, then chisel-plowed (or the near-surface zone in some was mixed using available equipment) to achieve a useful degree of incorporation. Only then would seeding occur using a mix adapted to site factors and seeding methods. Following that, dozer basins are constructed and seeded. The basins should be smaller (e.g., using a caterpillar D6R tractor or equivalent) and more widely spaced than in Section 31.
- Transplanting can occur several years following seeding when any interseeding has been done and herbaceous plants are well established. Individual planting spots are then selected based on site appearance and proximity of herbaceous plants (i.e., competition).

- Mechanically amend, incorporate, and then seed steep-slope areas, including harrowing to bury some of the seed. The objective is to revegetate entire slopes, not just basins and scraped areas. The objective is not to make slopes appear as a bombing range.
- Following seeding, install fewer, smaller dozer basins, then hand-seed them.
- Start transplanting a few years later in case areas have to be reseeded.
- Prospect for the best transplanting spots based upon site factors and lack of herbaceous competition.

Mt. Haggin Injured Area Vegetation Map

Final Report (With Separate Map)
August 8, 2006

by

Greg Kudray Ph.D.
Senior Ecologist
Montana Natural Heritage Program

The objective was to create a general vegetation map of the approximately 4,050 acre study area. Color infrared imagery from 2005 was used as a base layer to digitize polygons. I walked into the area from two different locations and recorded 14 GPS points that were accompanied by a total of 57 photos. The GPS points were often on high ridge tops where photos could be taken in every direction to document vegetation types and serve as an aid to mapping. I primarily focused on the lower cover non-forested types.

Overall the vegetation is quite variable and often in small patches that occur because of localized wet or dry conditions due to landscape position, or the success of a colonizing species – like the circular aspen patches spreading from root suckers. Much of the vegetation was previously heavily impacted by industry and is in an early successional stage. The mapped vegetation polygons are named for the dominant vegetation within the polygon but may also have small inclusions of different vegetation types. The invasive plant leafy spurge was common, especially in the northern half.

The following five vegetation types were recognized and used as mapping types. The Bare and Degraded Grassland types were further subdived by slope and aspect (Table 1). A 0.5 acre size was chosen as the minimum map unit for the slope calculation. We then smoothed the output with a 3 X 3 majority dominance window to recode scattered small patches to the cover type of the larger matrix type.

1. Bare: These areas are primarily found on ridge tops and steep ridge sides. Exposed soil and various sizes of gravel or rock were the typical ground cover with a variety of scattered grasses and forbs sometimes present.
2. Forest – Conifer: None of these areas was visited but douglas – fir is probably the most common tree along with lodgepole pine, based on the surrounding forests. These types occur where aspect and/or elevations combine to create a more favorable moisture regime.
3. Dense Shrub/Aspen: Most of these areas were found in valley bottoms or in other areas like north-facing slopes where more mesic conditions occur. The best developed stands were in riparian areas with running water (in June). A variety of willow species occur with small to medium sized quaking aspen trees. Some areas had only shrubs while others were small, somewhat stunted, aspen groves. Riparian areas typically had a ground cover of introduced pasture grasses like Kentucky bluegrass or quack grass.
4. Degraded Grassland: A variety of grasses occur but redtop dominates. Low shrubs like those listed in the Moderate Shrub Cover/Low Conifer Cover type are also common.
5. Moderate Shrub Cover/Low Conifer Cover: These types have a heavier cover of shrubs than the Degraded Grassland but less than the Dense Shrub/Aspen type. The shrubs present, like snowberry or skunkbush sumac, occur on drier sites than the willows of the

Dense Shrub/Aspen type. Oregon grape and wild rose are also common. Scattered conifers are sometimes but not always present.

Table 1. Acreage summary

Type	Total Acres	N to E aspect	E to S aspect	S to W aspect	W to N aspect
Bare Total	753.3 (18.6%)	135.2 (18.0%)	193.1 (25.6%)	287.5 (38.2%)	137.4 (18.2%)
> 35% Slope	568.6 (75.5%)	83.2 (14.6%)	130.4 (22.9%)	232.2 (40.8%)	122.9 (21.6%)
< 35% Slope	184.7 (24.5%)	52.0 (28.2%)	62.7 (34.0%)	55.3 (29.9%)	14.5 (7.9%)
Degraded Grassland	1712.2 (42.2%)	675.8 (39.5%)	308.2 (18.0%)	376.9 (22.0%)	351.3 (20.5%)
> 35% Slope	1304.9 (76.2%)	494.5 (37.9%)	202.3 (15.5%)	288.9 (22.1%)	319.2 (24.5%)
< 35% Slope	407.3 (23.8%)	181.3 (44.5%)	105.9 (26.0%)	88.0 (21.6%)	32.1 (7.9%)
Dense Shrub/Aspen	753.9 (18.6%)				
Forested - Conifer	197.7 (4.9%)				
Moderate Shrub/Low Conifer	635.2 (15.7%)				
Total	**4052.3**				

SEED MIXES – STUCKY RIDGE OR MT HAGGIN

Actual application rates will vary, especially broadcast seeding.

Seeding and Site Types:

1) Coarse, droughty substrates, often warm-aspect.

2) Coarse, droughty substrates, often warm-aspect; Seed can be thrown on the ground surface.

3) More soil fines, fewer rock fragments.

4) Coarse substrates, seed must be incorporated into the ground, Shrub Mix

1) Coarse, droughty substrates, often warm-aspect; Seed can be planted into the ground.

Heavy seed; Place into the ground

PLS	SPECIES	
3	Indian ricegrass	Rimrock
2	Thickspike wheatgrass	Critana
1	Needle-and-thread	
½	R.M. bee plant	
1 ½	Alfalfa, Yellow-flwr	
1 ½	Bluebunch w.	Secar
1	Canada widlrye	

10.5		

Light seed; place on surface, slightly compact

PLS	SPECIES
¾	Rubber rabbitbrush clean
1/3	Prairie sagewort
1 ½	Alfalfa, Yellow-flwr
2	Sheep fescue, Covar
½	Yarrow
1/3	Tarragon
½	Mountain big sagebrush clean
1	Big bluegrass #Bridger PMC
½	Silver Sagebrush

7.4	

2) Coarse, droughty substrates, often warm-aspect; Seed must be thrown on the ground surface.

PLS	SPECIES
1	Rubber rabbitbrush clean
½	Prairie sagewort
2 ½	Alfalfa, Yellow-flwr
2	Sheep fescue, Covar
½	Yarrow
½	Tarragon

¾	Silver sagebrush
2	Big bluegrass # Bridger PMC
½	Pacific aster
¼	*Penstemon nitidus* or more avail. *P. procerus*

10.5	

3) More soil fines, fewer rock fragments; Seed can be planted into the ground.

Heavy seed; Place into the ground

PLS	SPECIES	
1	Indian ricegrass	Rimrock
1 ½	Thickspike wheatgrass	Critana
3	Basin wildrye	Trailhead
2	Slender wheatgrass	Copperhead
2	Canada wildrye	
¾	Needle-and-thread	
½	R.M. bee plant	
1 ½	Alfalfa	Rhiz.
1	Fourwing saltbush	

13.25		

Light seed; place on surface, slightly compact

PLS	SPECIES	
1 ½	Sheep fescue	Covar
1 ½	Alfalfa	Rhiz
½	Rubber rabbitbrush	clean
¼	Winterfat	
½	Mtn. big sagebrush	clean
¼	Fringed sagewort	
¼	Cudweed sagewort	
1	Prairie junegrass	
1	Big bluegrass #Bridger PMC	

6.75		

4) Shrub & Subshrub Seed Mix -- expensive, must be tested

Must be incorporated into ground, not on surface

Chokecherry	2
Kinnikinnik	1
Berberis repens	1
Wood rose	1
Symphoricarpos oreophilus	1
Bitterbrush	1
	--
	7

TABLE 4
2002 Stucky Ridge RA
Quantities of Material

MATERIAL	QUANTITY
Tillage to 12 inches (T12) (Acres)	125.8
Lime Application (T12) (Acres)	122.2
Re-Lime Application (T12) (Acres)	5.6
Rock Rake Areas (T6) (Acres)	7.0
Rock Rake Areas Lime Application (T6) (Acres)	7.0
Lime Amendment (Tons)	2490 (249 loads)
Mulch (Acres)	8.5
Seed (Pounds Pure Live Seed)	3292 lbs (Reveg Mix 1) 1150 lbs (Reveg Mix 6)[1]
Tillage Fertilizer (12-18-30)	approximately 63,000 lbs
Broadcast Fertilizer (SSR)	approximately 14,000 lbs
Hydroseed (Acres)	1.0
Woody Species Tubelings (PTSG)	23,690 (planted in Fall 2003)
Fertilizer (Restoration Pak)	23,690 (applied Fall 2003)
Dozer Basins (Acres)	27.7
Rock Grade Control Structures	4
Stone Check Dams	46
Soil Filled Geo Bag Dams	9 (approximately 100 bags)

Notes:

1. 750 lbs of Reveg Mix 6 was seeded on the dozer basin areas during the fall of 2002.

ANACONDA SMELTER NPL SITE

ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT

Remedial Design Unit (RDU) 15 – Mt. Haggin Uplands Final Remedial Action Work Plan

Atlantic Richfield

Butte, Montana

October 2007

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LIST OF APPENDICES

LIST OF ACRONYMS and ABBREVIATIONS

ABA	Acid-Base Account
ADLC	Anaconda-Deer Lodge County
Agencies	EPA and MDEQ
AMC	Anaconda Mining Company
ARAR	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
Atlantic Richfield	Atlantic Richfield Company
ARTS	Anaconda Revegetation Treatability Study
ARWW&S	Anaconda Regional Water, Waste, and Soils
BERA	Baseline Ecological Risk Assessment
BMP	Best Management Practices
CCE	Calcium Carbonate Equivalence
CCR	Construction Completion Report
CDM	CDM Federal Programs Corporation
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CGWA	Controlled Ground Water Area
CPMP	Community Protective Measures Program
CQAP	Construction Quality Assurance Plan
CSK	Confederated Salish & Kootenai Tribes
DCR	Design Criteria Report
DNRC	Montana Department of Natural Resources and Conservation
DPS	Development Permit System
EC	Electrical Conductivity
EPA	U.S. Environmental Protection Agency
FDR	Final Design Report
FRLU	Final Remedial Land Unit
GWMP	Ground Water Management Plan
IC	Institutional Controls
ICMP	Institutional Controls Management Plan
LRES	Land Reclamation Evaluation System
LT	Light Till
MDEQ	Montana Department of Environmental Quality
mg/kg	Milligrams per kilogram
mg/L	Milligram per liter
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
M&M	Monitoring and Maintenance
M-WV	Monitor – Well Vegetated
OU	Operable Unit
OM	Organic Matter
OW/EADA	Old Works/East Anaconda Development Area

PDP	Preliminary Design Package
POC	Point of Compliance
ppm	Parts per million
PRLU	Preliminary Remedial Land Unit
PRP	Potentially Responsible Party
PTSG	Planting of Trees, Shrubs, and Grasses
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAG	Remedial Action Goal
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RACCR	RA Construction Completion Report
RD	Remedial Design
RDU	Remedial Design Unit
RDWP	Remedial Design Work Plan
RFC	Request for Change
RI	Remedial Investigation
ROD	Record of Decision
RRU	Reclamation Research Unit
SAP	Sampling Analysis Plan
SAR	Sodium Adsorption Ratio
SMP	Site Management Plan
SPAOD	Superfund Planning Area Overlay District
SSR	Steep Slope Reclamation
STARS	Streambank Tailings and Revegetation Study
TI	Technical Impracticability
TSS	Total Suspended Solids
T6	Insitu Treatment to 6 inches
T12	Insitu Treatment to 12 inches
T18	Insitu Treatment to 18 inches
USFWS	U.S. Fish and Wildlife Service
µg/L	Micrograms per Liter
WMA	Waste Management Area
WV	Well-Vegetated

REMEDIAL ACTION WORK PLAN
RDU 15 – Mt. Haggin Uplands
ARWW&S Operable Unit

1.0 INTRODUCTION

This Remedial Action Work Plan identifies the methods and procedures that will be followed for the implementation and management of the Anaconda Regional Water, Waste, and Soils (ARWW&S) Operable Unit (OU) Uplands Remedial Action (RA) for the Mt. Haggin Uplands remedial design unit (RDU). Performance of the RA is described in this RAWP, in addition, this RAWP also sets forth task-specific methods or approaches and schedules and other provisions to comply with performance standards and other criteria required by the Record of Decision (ROD) (EPA & MDEQ, 1998) and identified in the RDU 15 Final Design Report (Atlantic Richfield, 2007).

This RAWP was written with Atlantic Richfield as the responsible party for implementing the work. Atlantic Richfield anticipates a settlement will occur with the State of Montana. Should the State of Montana implement the remedial action work, the responsible parties outlined in the RAWP will be modified as appropriate.

1.1 Final Design Report/Remedial Action Work Plan Organization

RDU 15 – Mt. Haggin Uplands is one of 16 RDUs designated at the ARWW&S OU. A Final Design Report (FDR)/Remedial Action Work Plan (RAWP) will be prepared for each RDU. The site-wide design also includes several site-wide Management Plans that affect the implementation of the Remedial Action (RA) for RDU 15. These site-wide documents are as follows:

- Site Management Plan (SMP);
- Institutional Controls Management Plan (ICMP);
- Monitoring and Maintenance (M&M) Plan;
- Data Management Plan (DMP).

The design for RDU 15 is included in two documents. The FDR and the RAWP for RDU 15 which include:

FDR The FDR provides the remedial action objectives (RAOs), Selected Remedy, and remedial requirements of the ARWW&S OU ROD, summarizes the results of design investigations and analyses that have been completed since the ROD; presents the basis of design for each remedial design component (soils, surface water, ground water, and institutional controls), and identifies key design criteria and ARARs.

The FDR also, summarizes the existing data, discusses and evaluates remedial alternatives evaluated during the design, and presents the final design, and design drawings (scales of 1”=500’ and 1”=800’). An analysis of how the design is expected to achieve RAOs and performance standards is also presented in the FDR.

RAWP The RAWP identifies project roles and responsibilities; procedures to implement the RA; specifications, a quality assurance plan, and construction drawings (scales of 1"=500' and 1"=800'); pre-construction activities; construction tasks; monitoring, inspection, and maintenance requirements.

1.2 Remedial Action Work Plan Organization

This RAWP has been organized into the following sections:

- Section 1 provides a brief introduction to RDU 15 and the associated organization of the RDU 15 RD/RA;
- Section 2 provides a description of the Project Management and associated activities for the RDU 15 RA;
- Section 3 describes the activities that will occur prior to commencement of the RA within RDU 15;
- Section 4 identifies the RA for contaminated soils within RDU 15;
- Section 5 identifies the RA for surface water within RDU 15;
- Section 6 identifies the RA for ground water within RDU 15;
- Section 7 identifies institutional controls associated with the RDU 15 RA;
- Section 8 identifies post-RA reporting requirements;
- Section 9 discusses monitoring and maintenance requirements;
- Section 10 discusses delisting/deletion guidance; and
- Section 11 lists the references cited in this report.

This RAWP includes the following Appendices containing information supporting the RA:

- Appendix A – Construction Drawings and Design Information
- Appendix B – Technical Specifications
- Appendix C – Construction Quality Assurance Plan (CQAP)
- Appendix D – Construction Storm Water Erosion Control Plan (CSWECP)

2.0 PROJECT MANAGEMENT AND COMMUNICATIONS

The purpose of this section of the RAWP is to provide guidance to efficiently manage the RA, including defining lines of authority, communication, project coordination, project meetings and submittal requirements. The roles and responsibilities of the organizations involved in the RA are described in Section 2.1.

2.1 Project Organization, Roles and Responsibilities

The organizations that will be involved in the RDU 15 RA include the following:

- EPA Region VIII;
- Montana DEQ;

- Atlantic Richfield;
- Montana Department of Fish Wildlife and Parks;
- QA/QC Oversight Personnel; and
- Construction Contractor(s).

The EPA, in consultation with DEQ (the Agencies), will have the authority for final approval of the RA. The project CQAP is presented in Appendix C. Atlantic Richfield will periodically provide QA/QC results and other information to the Agencies to keep them informed of the progress of the RA. The Agencies will also be responsible for reviewing project schedules and submittals provided to them by Atlantic Richfield or its designated representative. The EPA will address all communications to Atlantic Richfield or its designated representative.

Atlantic Richfield or its project representative will be responsible for providing construction management and verifying that the RA complies with this RAWP and construction ARARs. Atlantic Richfield or its project representative will manage the project to focus on attaining the objectives outlined in the FDR. Atlantic Richfield and EPA will coordinate to provide all project related communications to Federal, State and local agencies, the public, the landowner, as appropriate, and all other involved or interested parties. Remedial Action activities will be coordinated by Atlantic Richfield or its project representative to adhere to the agreed upon schedule.

The QA/QC Oversight Personnel will report directly to Atlantic Richfield and will provide technical assistance on the project by performing QA/QC oversight of the Construction Contractor's work. The QA/QC Oversight Personnel will evaluate the Contractor's compliance with the RAWP and applicable site performance standards. Any deviations from this work plan will require the approval of both Atlantic Richfield and EPA.

The Contractor(s) will be responsible for performing the designated activities associated with the RA in accordance with this plan and other applicable documents. The Contractor will be responsible for communicating directly with the Atlantic Richfield project representative and or QA/QC Oversight Personnel on all issues and concerns. The Contractor will be responsible for scheduling the project activities with its Subcontractors to complete certain work tasks by the associated milestone dates. The Contractor will designate a primary contact person as the Contractor's site representative. This person will have full authority to make all necessary field decisions and to direct the work for the Contractor.

The Design Engineer will report directly to Atlantic Richfield and will provide technical assistance throughout the duration of the project. The Design Engineer will verify the Contractor's compliance with the Construction Drawings (Appendix A) and the Technical Specifications (Appendix B).

2.2 Property Owner

Land within the area addressed by this RAWP is owned by the State of Montana. Atlantic Richfield is the responsible party for implementing the remedy within RDU 15. Land ownership is shown on Sheet 3 of the Construction Drawings provided in Appendix

A of this RAWP. Atlantic Richfield will coordinate with and disseminate information to the land owners regarding remedial activities.

The landowner will be required to grant access for RA implementation and monitoring and maintenance. A Landowner Access Agreement will be executed between Atlantic Richfield and the landowner. This agreement will allow Atlantic Richfield and the Agencies access to the property for remedial action implementation and post-implementation monitoring and maintenance. The Agreement will also specify post-RA land management requirements (i.e. grazing, weed control, various County ordinances) for land use and identify post-construction land management requirements to ensure that the remedy is not adversely impacted.

2.3 Project Meetings

A pre-construction conference involving representatives from Atlantic Richfield, EPA, DEQ, the QA/QC Oversight Personnel, the Design Engineer (as necessary), the Contractor and the State of Montana will be scheduled before initiating any work at the site. The purpose of this pre-construction meeting is to assure that all parties understand their respective responsibilities and the procedures that will be used to assure efficient completion of the work. The meeting will discuss scheduling (including critical milestone dates), submittal procedures, recordkeeping, use of premises, site security, health and safety procedures, material and equipment delivery and staging/storage requirements/procedures.

Progress meetings involving representatives from Atlantic Richfield, EPA, DEQ, the QA/QC Oversight Personnel, the Design Engineer (as necessary), the Contractor's site representative and the State of Montana will be held weekly at the job site. The progress meetings agenda will include, at a minimum, the status work items initiated to date, scheduled work items for the following week, problems encountered and proposed solutions, and any health and safety or historical issues that have arisen in the past week or issues that are pertinent to the work scheduled for the following week.

2.4 Documentation of the Remedial Action Implementation

The RA will be documented and controlled via the Drawings (Appendix A), Technical Specifications (Appendix B), CQAP (Appendix C), approved design change procedures, reporting and record keeping and information /data storage.

2.4.1 Construction Drawings and Technical Specifications

Construction Drawings for RDU 15 Area 1 are presented in Appendix A. The Technical Specifications are provided in Appendix B. The specifications and drawings provide the requirements for how the design is to be implemented. The CQAP provided in Appendix C describes the oversight observations and measurements that are required to ensure the design is implemented according to the requirements set forth in the specifications and on the drawings. Documentation of the adherence to the design and specifications is provided in the CQAP and is discussed below. Both the Technical Specifications and the CQAP refer to construction oversight by an Atlantic Richfield representative however, if an agreement is reached with the State to implement the RA, the oversight will be performed by the State's Contractor and independent QA/QC Oversight Personnel.

2.4.2 Procedures to Implement the Construction Quality Assurance Plan

The Uplands CQAP presents QA/QC requirements for general construction procedures such as mobilization, construction BMPs, lime amendment, tillage, organic matter amendment, fertilizing, seeding, dust control, and general requirements for RDU 15 Area No. 1. The CQAP is provided as Appendix C. Also presented in the CQAP are requirements associated with controlling construction-related oils, fuels and other materials. The QA/QC Oversight Personnel will provide oversight of the contractor during construction to assure compliance with all sections of the CQAP.

2.4.3 Design Changes

Changes in implementation or how the RA is performed that do not affect the design are considered minor and generally do not require formal approval. Changes to the design require formal approval. All changes to any portion of the design must be clearly delineated and described on a Request for Change (RFC) form provided in the CQAP. These completed forms will be used to update the As-Built Drawings, to provide a clear record of all field modifications, identify the exact location and reason for the modifications, and suggested alternatives and solutions to field complexities. Copies of RFC forms will be maintained at Atlantic Richfield's project trailer office and the Butte, Montana main office.

2.4.3.1 Design Change Category

2.4.3.1.1 Field Changes

Minor changes in the performance of the RA do not require the approval of Atlantic Richfield or the Agencies, and can be documented in the field log book. This could include the location of access roads, amendment stockpile locations, weed spraying chemicals, etc.

2.4.3.1.2 Design Changes

All design changes require the approval of Atlantic Richfield and the Agencies and will be identified on a RFC form. (See Uplands CQAP in Appendix C of this RAWP.) These include changes to locations of remedial technologies, use of different remedies, seed mix changes, etc.

If design changes are approved verbally by the Atlantic Richfield Construction Manager and the Agency oversight person, then the change must be documented in the Daily Construction Report and discussed in the As- Built report (RACCR).

2.4.3.2 Description of Change

Detailed notes should be made in the logbook, and digital photographs will be added to provide justification for on-site minor changes. When approval is sought for design changes, an RFC form will accompany the aforementioned documentation. All change requests submitted will be registered, and a RFC form will be issued accepting all changes, making modifications, or refusing the request.

2.4.3.3 Affected Documents

As-Built drawings should be updated as changes are planned and implemented. The RFC provides a mechanism to transfer changes up the chain of documentation.

2.4.3.4 Approval Process

The completed RFC will be submitted to the Atlantic Richfield representative, reviewed, approved and signed. The RFC will then be forwarded to the Agency oversight person and the Agency project manager for approval, modification and/or rejection. The signed RFC will then be returned to the Atlantic Richfield project representative.

2.4.4 Reporting and Recordkeeping

The RA contractor will record on a daily basis the following information, when applicable, during RA:

- Onsite equipment and personnel;
- Safety Incidents including preventive measures implemented;
- Material delivery and usage;
- QA/QC on required materials; and
- Laboratory analytical results on construction materials.

The QA/QC Oversight Personnel will perform various record-keeping duties and will be responsible for maintaining a complete and accurate record of all significant field observations, inspections and all field and/or laboratory testing and results. These records will be kept onsite for EPA review. The record-keeping activities will include, but are not necessarily limited to, the following:

- **Logbooks**. Logbook entries will document significant activities, observations and deviations from the Drawings or Specifications, key information regarding field sampling, safety issues, measurement and testing, photographs taken, and the topics/results of any significant meetings/discussions.
- **Quality Assurance Testing Documents**. Instrument calibration forms, field and laboratory measurement and sampling forms, sample logs, chain-of-custody forms and other documents related to quality assurance testing will be kept onsite with the Daily Project Logs. Sample forms for non-environmental sampling and testing are included in the CQAP. Summaries of relevant quality assurance and laboratory tests will be included in the Daily Project Logs.
- **Other Documentation**. Other documentation required may include, but is not limited to: material compliance certifications (as provided by the Contractor); materials testing results; manufacturer's recommended installation or operating instructions; site walk and site visit records; and signed pre- and post-construction landowner approval inspection records.

Atlantic Richfield will submit to the Agencies a monthly report of construction activities during RA phases. The monthly report will include, at a minimum, the following items:

- Monthly progress;
- Monthly quantities and production;
- Schedule modifications;
- Schedule projections; and
- Other appropriate information.

Upon completion of remedial activities within a RAWP area, a RA Construction Completion Report (RACCR) will be completed for Mt. Haggin Area 1 and submitted to the Agencies.

2.4.4.1 Remedial Action Project Files

The Daily Project Logs will be stored onsite in a binder to provide a readily available record of construction activities. These Daily Project Logs will be included as an appendix to the final "As-Built Completion Report" to provide a chronological description of construction activities through completion.

2.4.4.2 CQAP Data Management

All data collected as a part of CQA activities will be attached to the monthly reports and filed with them or provided at weekly progress meetings.

3.0 PRE-CONSTRUCTION ACTIVITIES

The following activities will be performed prior to starting RA construction.

3.1 Pre-Construction Site Walk

As determined at the pre-construction conference and as outlined in the SMP, a site walk between Agency personnel and Atlantic Richfield, or its designee, will be performed to identify any clarifications required prior to implementation. Polygon boundaries are based on current vegetation and landform. Identified polygon boundaries will be the basis of boundary evaluation during Pre-Construction Site Walk at which time boundaries may change to reflect "in–the-field" conditions. The site walk will also include addressing any issues associated with the RD, evaluating access areas, erosion control concerns, remedial boundaries (i.e., steep slope areas), amendment requirements (i.e., organic matter), weed problems that may require treatment, and any other factors that may influence the RA or the manner in which it is implemented. Drawings at a scale of 1"=200' will be provided for the Pre-Construction Site Walk.

3.2 Landowner Agreements

A landowner Agreement Form will be executed between Atlantic Richfield and each affected landowner. This agreement must be in place prior to construction activities and will allow Atlantic Richfield and the Agencies access to the property for remedial action implementation and post-implementation monitoring and maintenance. The Agreement will also specify post RA land management requirements (i.e. grazing, weed control, various County ordinances) for land use and identify post-construction land management requirements to ensure that the remedy is not adversely impacted, as necessary.

To the extent possible, remedial action activities will be coordinated with individual landowners to account for the intended land use (i.e., development of landowner specific seed mixes, integration of site specific structures such as roads, etc). These issues will be agreed upon with the landowner prior to construction and in accordance with the Landowner Agreements.

Landowners are required to manage their property in accordance with all existing state and county laws and ordinances (i.e., weed control). During implementation of the RA and until performance standards have been attained, Atlantic Richfield shall coordinate with landowners to manage the property in a manner consistent with success of the remedy. Upon completion of RA construction activities and achievement of performance standards, as outlined in the Final Vegetation Management Plan, property management reverts back to the landowner to manage the property so as to minimize erosion or degradation of the remedy (i.e. vegetation cover). Each landowner will be required to grant access for RA implementation and monitoring and maintenance. The Landowner Agreement may contain additional details regarding landowner requirements. Atlantic Richfield may arrange for landowners to participate in certain maintenance activities.

Future development of the property must comply with local and state building/development codes and requirements identified in the Anaconda Deer Lodge County (ADLC) Master Plan (ADLC, 1992a) and the Development Permit System (DPS) (ADLC, 1992b) and any revisions to those documents.

3.3 Wetlands and Historical and Cultural Resources

Wetlands, historic structures and cultural resources will be protected during RA implementation. During the pre-construction conference, site assessments for evaluation of these resources will be scheduled. Prior to commencing with remedial activities, assessments of the construction area will be performed during the site walk to evaluate any wetland or historic areas that could be impacted. Evaluation of wetland and historic areas are discussed in greater detail in the following paragraphs.

3.3.1 Wetlands

Remedial activities are anticipated within wetland areas in the vicinity of Cabbage Gulch, Muddy Creek and Joyner Creek. Some remedial activities (sediment pond construction) will occur within or in close proximity of wetland areas. Impacts as a result of these activities will be mitigated through the 4-step Upper Clark Fork River Wetlands Mitigation Process. Currently no formal assessment of wetlands has been completed for the RDU 15 area, however, wetlands will be delineated prior to remedy implementation. Wetland areas may be flagged prior to remedial activities if adjacent to a work area to prevent impact or disturbance to wetlands. Flagged areas will include a buffer distance as dictated by a qualified wetland specialist. Wetland vegetation types include cattail (*Typha latifolia*) marshes, willow (*Salix spp.)* dominated shrub communities, several types of graminoid-forb meadows, streamside herbaceous communities and aspen (*Populous tremuloides*) thickets. If identification of wetland areas is required prior to RA activities, identification and flagging will be completed by a qualified wetland specialist. The wetland assessment will follow the previously approved Upper Clark Fork River 4-step Wetland Mitigation Process. Atlantic Richfield will ensure that all contractors follow best management practices to minimize soil disturbance and erosion and to

maintain bank stability in wetland areas during construction. Loss of wetland habitat by wildlife, due to noise and construction activities, will be short-term. No long-term impacts to wetlands will occur as a result of the remedial activities.

3.3.2 Historic Resources

There are no identified historical features within the RDU 15 area that will be affected by RA activities. It is anticipated that no historical features will be impacted during the RA; however, if features are identified, and pursuant to ARARs, the following procedures will be initiated:

1. Atlantic Richfield and Agency construction oversight personnel shall be immediately contacted;
2. The Atlantic Richfield's project manager shall be immediately contacted by Atlantic Richfield's construction oversight personnel;
3. RA activities in the immediate vicinity of the identified feature shall be halted. Construction elsewhere on the project may continue; and
4. The requirements of the Regional Historic Preservation Second Programmatic Agreement (ARCO, 1994) and any subsequent amendments will be met.

3.3.3 Cultural Resources

It is anticipated that no new cultural features will be identified during the RA; however, if features are identified, and pursuant to ARARs, the following procedures will be initiated:

1. Atlantic Richfield and Agency construction oversight personnel shall be immediately contacted;
2. The Atlantic Richfield's project manager shall be immediately contacted by Atlantic Richfield's oversight personnel;
3. RA activities in the immediate vicinity of the identified feature shall be halted. Construction elsewhere on the project may continue; and
4. The requirements of the Regional Historic Preservation Second Programmatic Agreement and any subsequent amendments will be met.

4.0 CONTAMINATED SOILS REMEDIAL ACTION

4.1 Site Access

Primary access to RDU 15 will be obtained from Mill Creek Road, and the Wildlife Management Area road. All secondary roads are vehicle restricted and are anticipated to be used as necessary during implementation of remedial activities. No new access roads are to be constructed during implementation of remedial activities. Security for construction sites and staging areas will be provided by the RA contractor. This includes the construction and maintenance of fences and gates where necessary, as well as personnel to control access points. Atlantic Richfield retains the right to access any site and will keep copies of all necessary keys for such use.

4.2 Site Preparation

Weed spraying may occur before site preparation activities, as necessary, and to the extent that it will not impact existing desirable vegetation or result in residual impacts to seeded or planted species. Site preparation activities shall include, but not be limited to, mobilization of equipment and materials, stockpiling amendment, construction of access roads, as necessary, and placement of temporary erosion controls (e.g. silt fence around staging areas).

4.2.1 Weed Spraying

To the extent possible, weed spraying activities may be coordinated with the landowner so that it can be conducted prior to any site preparation activities typically in the spring/summer months prior to any remedial activity. The types of chemicals will depend on the noxious weed species present and any state or county listed noxious weed identified within the work area will be sprayed. It is anticipated that leafy spurge, spotted knapweed, and Canada thistle are the most likely to be problematic. Prior to implementation of remedies, weed control programs may be implemented within treatment areas, as necessary. Any herbicides used in this program will not have residual effects that could adversely influence the germination establishment and growth to seeded or planted species or impact existing desirable vegetation.

4.2.2 Road Improvements

Primary access to remediation areas within RDU 15 will be through existing roads (e.g., Mill Creek Road and the designated Wildlife Management Area road). Secondary access roads will be needed from these primary access points for delivery of amendments and equipment. However, designated haul roads and routes will not be required nor are rigid specifications required for the construction of these access roads. The RA will be performed with agricultural equipment capable of traveling cross-country. QA/QC Oversight Personnel responsibilities include monitoring roads for dust control.

4.2.3 Clear and Grubbing

Limited clearing and grubbing of vegetation debris will be performed within the RAWP area and will consist of that only necessary for access roads, staging/amendment storage areas or clearing of dead debris to allow for implementation of the remedial action (i.e. T6 or T12). To the extent possible, live vegetation will be preserved during construction related activities. LT areas will not be cleared and grubbed.

4.2.4 Grading

Site grading will be conducted, as necessary, for construction of staging areas for protection of surface water run-on/run-off. Grading will also be performed prior to tillage and steep slope activities in areas where existing erosion rills/gullies are sufficiently deep and pervasive that they serve as a limitation to amendment application and do not allow for effective and efficient tillage of the soil. Deep primary drainages will not be graded. For non-SSR areas, rills and gullies will be filled or smoothed as determined necessary by the contractor in order for equipment to implement the remedy. This may be accomplished during the pre-till but also may require the use of dozer/blade for more severe gullies (i.e. deeper than 12”). Grading of rills and gullies within the

construction areas will be evaluated during the pre-construction site walk to identify areas where grading may be required for implementation of the RA. To the extent possible, grading activities will be performed during clearing and grubbing of vegetation debris and shall work within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation. The RA contractor will be responsible for monitoring and verifying that site contouring is performed to the appropriate lines and grades, and that materials are placed in accordance with the Drawings and Technical Specifications.

4.2.5 Construction BMPs

Placement of construction BMPs (e.g. silt fence) shall be completed in areas of concentrated flow that could impact Mill Creek. BMPs will be implemented when construction operations are in progress in and around natural drainages. During site work activities, standard BMPs will be followed to divert storm water around the work area and minimize storm water runoff from transporting sediments downgradient, to the extent practicable. These measures may include upgradient berms, straw bale check dams, temporary ditches and/or silt fence. See the Construction Storm Water Erosion Control Plan (Appendix D of this RAWP) for additional details.

4.2.6 Preservation of Existing Vegetation

Areas of existing trees and vegetation, as determined in the field and/or pre-construction walkthrough, will be maintained during implementation of the RAs, to the extent possible. As necessary, improvement or enhancement of these areas will be performed to achieve compliance with performance standards. The species present within these areas have been used as guidance for development of the design. Emphasis shall be placed on mature vegetation given the time required to grow to maturity and on preservation of native grasses and forbs. Forbs, in particular are difficult to establish from seed. Tilling activities will be implemented within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation. Tillage will take place up to and adjacent to well vegetated areas. Tillage will be performed up to the edge of root mass for trees and shrubs not cleared and grubbed. To the extent that safety is not compromised and existing desirable vegetation is not impacted, tillage areas will overlap into adjacent polygons of good vegetation.

4.3 Material Storage

Data for development of the lime rate and all lime rate calculations for the Mt. Haggin area are provided in Appendix A – Table A-3 and rock content calculations are shown in Appendix A – Table A-4 of the Mt. Haggin FDR. Lime rate requirements and associated rock contents for correction of the lime rate for the RAWP area are included separately on the attached drawings (Sheet 7 in Appendix A).

Remediation of the RAWP area in RDU 15 will require use of lime, fertilizer and organic amendments, as necessary, to enhance the establishment of vegetation. Amendments will be stockpiled in primary staging locations and moved to areas of implementation immediately prior to remedial activities. The RA contractor will be responsible for identifying these areas and access to them in consultation with Atlantic Richfield and the affected landowner.

Dust and erosion control methods are provided in the Specifications and CQAP. The RA contractor will perform dust control in accordance with the Specifications to minimize fugitive dust emissions. Atlantic Richfield's IQAT representative will also verify that dust control is applied to the appropriate locations.

Based on previous sampling results, specific air monitoring is not required for this work. Best management practices will be followed to control fugitive dust, and maintain compliance with State ambient air quality regulations. Fugitive dust control measures that may be employed during the RA include:

- Watering haul roads;
- Vehicle speed restrictions;
- Avoiding lime activities during periods of high winds;
- Placement of covers (tarps) over lime stockpiles; or
- Minimizing area of disturbed land.

The need for dust suppression will be determined based on visual observations during construction activities.

4.4 Sequencing

The sequencing of revegetation activities for RDU 15 will begin with mobilization, site preparation, tilling, liming, steep slope remediation, fertilization, and seeding of specified areas (See Sheet 7 in Appendix A). Weed spraying may be performed, as necessary during the appropriate time of year for the target weed species within the remediation area to the extent that construction activities or vegetation establishment will not be impacted. Herbicides used will depend on the specific noxious weeds species and its location on the landscape as approved by the landowner. Weed spraying equipment will also vary based on the weed infestation and weed location. For, example, back pack sprayers would be used for spot spraying on inaccessible areas whereas tractor mounted boom sprayers would be used in heavily infested flatter terrain. Planting of tree and shrubs will be performed in either the spring or fall depending on stock availability and project scheduling and will typically be the last RA activity implemented.

Possible sequencing interruptions may occur due to weather conditions or construction problems that delay scheduled weed spraying, lime amendment application, or seeding. If weed spraying delays occur due to rain or wet weather conditions prior to the RA, areas may require a more stringent post-remediation weed control effort. Species (Specification 02940-Seeding) should be seeded from October 1st through June 15th. After these dates, it is generally undesirable for seeding grass/forb seed mixes. If, for some reason, an area is not seeded during the optimum dates, then seeding will be postponed until the next available planting/seeding time. Tilled areas that are not seeded due to missing the above time constraints may require summer erosion control protection. These areas shall be seeded with an annual cover crop of barley or other suitable species (annual rye) at 10 pounds of live seed (PLS) per acre.

4.5 Soil Treatment

T12 (Tillage to 12 inches depth). Tillage to 12 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels in soils cannot be reduced to less than the relevant action level through T6. Tillage of soils to a 12-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 12 inches will reduce metals concentrations by mixing the upper soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T12 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations and lime application rates are provided in the Design Criteria Summary Tables in Appendix A. Lime rates and associated calculations for areas requiring lime are also provided in Table A-3 of the FDR. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 12 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval, and greater than 6.0 s.u. in the 6 to 12-inch interval.

Following implementation of the T12 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via the T12 alternative will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. **There are an estimated 11 acres of T12 within RDU 15**.

T6 (Tillage to 6 Inches). Tillage to 6 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels are located in the upper soil layer. Tillage of soils to a 6-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 6 inches will reduce metals concentrations by mixing the surface soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Predicted resulting COC concentrations within the tilled interval for areas requiring T6 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Lime application rates are provided on Sheet 7 in Appendix A. If lime amendment is required, it will be applied at the 0-6" lime rate with no pre-till required. Lime rates and associated calculations for areas requiring lime are also provided in Table A-3 of the FDR. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 6 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP

Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval.

Following implementation of the T6 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via the T6 alternative will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. **There are an estimated 14 acres of T6 within RDU 15.**

Tilling activities will work within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation.

OM (Organic Matter Amendment). The use and need for organic matter amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis. Site-specific factors will be used to evaluate the need for OM. In areas where OM is determined to be required based on the absence of an A-horizon, OM will be incorporated into the 0-6 inch interval. The OM amendment shall have a 1 inch maximum particle size. Any particles larger than 1 inch will not be considered in the determination of OM content. The following criteria were used to determine when the use of OM is appropriate:

- In treatment areas only, i.e. T12 and T6. Not in Light Tillage, Steep Slope Remediation or Monitoring areas.
- Throughout the soil profile where elevated metals (arsenic greater than 1,000 mg/kg) are present following mixing and reduction.
- Where a continuous A-horizon can not be identified. (A visually identifiable soil A-horizon is defined as being in the range of four to six inches with the soil exhibiting a dark soil color consistent with conventions of soil taxonomy.)

In addition, organic matter may be added in other areas where it is determined by Atlantic Richfield that organic matter addition would facilitate enhanced establishment or to jumpstart vegetation establishment (i.e., in drainages, fluvial outwash areas or areas where COCs are determined to be at levels that may influence normal vegetation establishment).The amount of OM amendment required for a given polygon will be determined prior to tilling during remedial action. The OM content of the soils will be determined by observation of a series of hand dug pits (one per 10 acres) in tillage areas by Agency and Atlantic Richfield representatives prior to implementation of the remedy. If a continuous A-horizon cannot be identified, the following approach shall be utilized to determine OM content:

1. For areas receiving LT, T6 and T12 remediation, one composite sample consisting of at least 5 sub-samples for the 10-acre grid will be collected prior to remedial action from the interval to be tilled (i.e., 0- to 6-inch interval for T6 and LT, and 0- to 12-inch interval for T12) and analyzed for organic matter content using the Walkley Black Procedure.

   Based on analyses, the OM content of the upper six inches of the soil profile within tillage areas, where OM is required, will be adjusted to achieve 1.5 percent OM in the top six inches based on dry weight or 3% throughout the soil profile in the case that the soil arsenic concentration cannot be reduced via tilling to below 1,000 mg/kg.

2. For areas receiving T18, organic matter amendment shall be added at a rate of 1.5% (dry weight) to the 0- to 6-inch profile.

If required, OM amendment will be incorporated following lime application (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment) prior to seeding. Application of OM will be performed in accordance with Specification Section 02970 – Organic Amendment and Mulching and CQAP Section 02970 – Organic Amendment. The need for organic matter will primarily be determined during the site walk.

In addition, organic matter may be added in other areas where it is determined by Atlantic Richfield that organic matter addition would facilitate enhanced establishment or to jumpstart vegetation establishment (i.e., in drainages, fluvial outwash areas or areas where COCs are determined to be at levels that may influence normal vegetation establishment).

4.5.1 Mulch

Transition Zones, defined as the area between a SSR area and an upgradient tillage area (See Section 4.7) and areas in close proximity to public right-of-ways (i.e. adjacent to Mill Creek Road) may be straw mulched/crimped at a rate of approximately 2,000 pounds per acre (one ton per acre) to provide protection against soil erosion during establishment of vegetation in the tilled areas, as appropriate. These areas will be delineated during the site walk.

4.5.2 Seedbed Preparation

Seedbed examination and preparation are described in Specifications 02940 Seeding Part 3. Equipment may include agricultural type tractor, standard agricultural disks, harrows, or plows needed to till the soil at a minimum depth of 6-inches. Seedbed preparation will be performed following fertilizing so that fertilizer shall be incorporated into the upper 3 to 4-inch soil profile.

4.5.3 Amendments

Remediation of RDU 15 RAWP Area No. 1 will require use of amendments including lime, fertilizer, and in some areas, organic matter, to enhance the establishment of vegetation. Amendments required on a polygon by polygon basis are identified on Sheet 7 of the Construction Drawings provided in Appendix A.

4.5.3.1 Lime

Tillage areas where lime is required to neutralize soil acidity will be limed using the maximum lime rates for the polygons as presented on Sheet 7 of the Construction Drawing provided in Appendix A. The lime rates presented on Sheet 7 (Appendix A) will be corrected for lime quality and minimum rock content (identified on Sheet 7) prior to implementation. In RDU 15 RAWP Area 1, approximately 25 acres of T6 and T12 treatment areas will receive lime amendment. The technical requirements for use of these amendments are presented on Sheet 7 (Appendix A) and in the Technical Specifications provided in Appendix B of this RAWP.

4.5.3.2 Fertilizer

Fertilization rates are based on typical rates already applied at other approved Atlantic Richfield revegetation projects. All tillage areas within this project area will be fertilized at the same rate of 500 pounds per acre (12% N/ 16% P_2O_5/ 30% K_2O). No fertilizer will be applied within several feet of saturated soils (wetland) or inundated areas (edge of water/inside dry stream channel) to minimize the potential for release of fertilizer to surface waters. Fertilizer will be broadcast over the tilled soil surface and incorporated after tilling and prior to seeding during seedbed preparation. The fertilizer will be broadcast spread, either with a tractor or by hand using a hand operated cyclone spreader and incorporated during seedbed preparation using a chisel plow or other appropriate method of preparing the tilled surface for seeding. Fertilization specifications are presented in Specification 02960-Fertilization (Appendix B).

4.5.3.3 Organic Matter

The need for organic matter amendment within areas to be remediated using T12 or T6 will be determined during the site walk with Agency personnel to asses the presence of the soil A-horizon within tillage areas. A visually distinct soil A-Horizon is defined as being in the range of four to six inches with the soil exhibiting a dark soil color consistent with conventions of soil taxonomy. It is anticipated that some tillage areas (i.e. T12, T6) will require the addition of organic matter. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval to achieve a final organic matter content of 1.5%.

OM amendment shall have a 1 inch maximum particle size. Any particles larger than 1 inch will not be considered in the determination of OM content. All amendment material will be visually inspected by the QA/QC Oversight Personnel to ensure proper stockpiling and storage measures are followed as described in the Technical Specifications (Appendix B). In addition, periodic sampling will be performed to assess the quality of stockpiled material in accordance with appropriate CFRSSI SOPs (ARCO, 1992).

4.5.4 Seeding

One primary seed mix has been developed for tillage areas within Mt. Haggin Area No. 1 based on site-specific hydrologic regimes, soil texture, slope and aspect. This mix is Revegetation Mix 1 (Specification 02940-Seeding, Appendix B and Sheet 7 in Appendix A).

Revegetation Mix 1 includes species that have been demonstrated to be successful at other areas of the Smelter NPL Site and includes a mixture of rhizomatous and bunch grass species that will aid in reducing soil erosion. Revegetation Mix 1 contains species adapted to a variety of soil moisture and soil textures that will provide both short-term and long-term erosion control, soil stabilization and vegetation cover.

REVEGETATION MIX 1

UPLAND SEEDED HERBACEOUS SPECIES

(BASIC SEED MIX FOR UPLAND GRASSLAND AREAS)

Scientific Name	Common Name	Variety	Percent of Mix (Pure Live Seed Weight Basis)
Grasses			
Agropyron trachycaulum	Slender wheatgrass	Revenue	15
Agropyron smithii	Western wheatgrass	Rosanna	10
Agropyron dasystachyum	Thickspike wheatgrass	Critana	15
Agropyron spicatum	Bluebunch wheatgrass	Goldar	10
Elymus cinereus	Great Basin wildrye	Magnar	15
Poa ampla	Big bluegrass	Sherman	14.5
Festuca ovina	Sheep fescue	Covar	10
Oryzopsis hymenoides	Indian ricegrass	Nezpar	5
Forbs/Subshrubs			
Artemisia frigida	Fringed sagebrush	NA	0.5
Achillea lanulosa	Western yarrow	NA	2.5
Linum lewisii	Common blue flax	Appar	2.5

Notes:

1. If unavailable or cost prohibitive, *Poa sandbergii*/sandberg bluegrass may be substituted at the same seeding percentage.

In areas receiving Revegetation Mix 1, a cover crop will be planted to provide interim protection during the establishment year, to help control wind and water soil erosion on disturbed areas, and to help combat establishment of weeds. Since cover crops compete for water, light, and nutrients, they must be compatible with the seedling forage. Areas will be seeded with an annual cover crop of Barley or other suitable species (annual rye).

The cover crop will be incorporated into the upland seed mix at a rate of 10 pounds PLS/acre.

Seeding methods and procedures are presented in Specification 02940-Seeding. Polygons and the associated seed mix to be implemented within each RAWP area are shown separately on Sheet 7 in Appendix A. Acknowledgment of individual landowner seed mix requests will be addressed in the Landowner Agreement and will be incorporated into the drawings once identified.

Seeding equipment may include a custom seeder or any drill seeder that is approved by the Agencies and Atlantic Richfield field representatives. Two seeding methods will be used, as appropriate: broadcast seeding and drill seeding. Small areas inaccessible to equipment and steep slope areas will be broadcast seeded by hand. Seeding of steep slope areas is discussed in Section 4.6. All tilled areas will be drill-seeded. Seeding methods and procedures are presented in Specification 02940-Seeding.

4.6 Steep Slope Reclamation (SSR)

Steep slope areas are identified by a pitch steeper than 3H:1V. The RDWP (EPA, 2000) identifies four types of SSR. The techniques to be implemented for SSR are:

1. SSR-1 –Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs;
2. SSR-2 –Broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs that do not require mechanized equipment (e.g., brush boxes, straw bales, wattles, check dams and other BMPs);
3. SSR-3 –Broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins); and
4. SSR-4 –Broadcast seeding in conjunction with planting of trees and shrubs, implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins), and slope regrading/recontouring.

For design and implementation purposes, the design drawings illustrate SSR remediation as specific activities or engineering controls, but the maps show only general locations and techniques to be implemented. Actual locations and SSR techniques will be determined during the “plan-in-hand” site walk based on site-specific conditions.

In some instances, a combination of SSR techniques has been prescribed (i.e. SSR-1/SSR-2). This remedial prescription is intended to imply that areas within the polygon of good vegetation and low erosion will be remediated with tree and shrub planting only (SSR-1), while areas within the polygon of poorer vegetation and more erosion will receive hand implemented BMPs and planting of trees and shrubs (SSR-2). Implementation of these less intrusive SSR techniques coupled with engineered controls, where applicable, will help reduce downstream sediment and COC transport.

4.6.1 Woody Species Selection and Location

The primary component of all Steep Slope Remediation (SSR) types is the planting of trees and shrubs and broadcast seeding of grasses. Trees and shrubs shall be planted on

side-slopes of steep sloped areas to help stabilize the soil, reduce runoff velocity and to encourage establishment of woody species. To help reduce erosion and reduce runoff from the steep slope areas, on-slope BMPs (i.e., brush boxes, dozer basins) will be constructed, as appropriate. Woody species shall be planted in conjunction with the on-slope BMPs to help reduce soil erosion, increase evapotranspiration and re-establish vegetation on the side-slopes. Specification 02930-Planting of Trees and Shrubs provided in Appendix B identifies a comprehensive species list for PTSG plantings. Suggested species for the polygons within the project area primarily include chokecherry, currant and Woods rose as well as Rocky Mountain juniper, Limber pine, Douglas-fir, Lodge Pole pine and Ponderosa pine. Chokecherry and currant will be concentrated in transition zones, (i.e. base of slopes or concave depressions and east/north facing slopes). Rocky Mountain juniper, Limber pine, Douglas-fir, Lodge Pole pine and Ponderosa pine will be planted on other slopes. Woods rose will be concentrated on the lower portion of the slope on both warmer and cooler aspects to aid in soil stabilization. The planting density for trees and shrubs in the Upland areas is 450 stems per acre, plus an additional 50 trees/shrubs per acre for the ten years following remediation. Tree/shrub plantings will be inoculated with mycorhizzae and will receive Restoration Pak fertilizer (11% N/17% P_2O_5/9% K_2O) in each planting hole. In conjunction with planting of trees and shrubs, SSR areas will be broadcast seeded using a mix consisting of Great Basin wildrye, western wheatgrass, bluebunch wheatgrass, big bluegrass and sheep fescue at a broadcast seeding rate of approximately 25 pounds per acre. This seed mix is identified in Specification 02940-Seeding, in Appendix B.

To the extent possible during planting of woody species on side-slopes, small depressions or basins around the plantings will be created to help retain surface water and provide additional runoff control. In areas where planting of trees and shrubs is implemented in conjunction with brush boxes and dozer basins, these BMPs will help retain surface water. **There are approximately 112 acres of SSR within RDU 15.**

Designs for this area are summarized in the Upland Design Criteria Summary Sheets (Appendix A) and the polygon locations are shown on Sheet 7 of Appendix A. PTSG methods and procedures are presented in Specification 02930-Planting of Trees and Shrubs in Appendix B.

4.7 Transition Zones

The Transition Zone is defined as the area between an upgradient hillside or hilltop (flatter than 3H:1V) treatment area (i.e. T6, T12, LT) where treatment ends due to slope steepness and the downgradient steep slope (as previously defined) located below the treatment area. Because vegetation in treatment areas may not be fully established for several years following treatment, it is necessary to construct temporary storm water BMPs to minimize potential erosion and sediment transport from the upgradient treatment area to the slope below. Although tillage equipment may not be able to operate safely in the Transition Zone, track-type tractor equipment such as dozers may be able to operate safely until the steepness of the slope exceeds 2H:1V as determined in the field. At the transition zone, if tillage is unable to extend to the start of the SSR area, dozers may be used to construct temporary BMPs such as dozer basins and temporary along-contour ditches, and to grade erosion rills and gullies, as determined in the field by construction oversight personnel. Areas of adequate existing vegetation or rock outcrops

will be avoided. While Transition Zones are identified on Sheets 6 and 7 as linear zones between treatment polygons and steep slope reclamation polygons downslope of the treatment areas, the width of the transition zone is unknown and will ultimately be determined during construction when the tillage limits become known. Transition areas are only applicable to SSR polygons with a remedy of SSR-1, SSR-1/SSR-2, SSR-2, SSR-2/SSR-3, and SSR-3 with an adjacent upgradient tillage polygon.

If a transition area is able to be tilled it will be seeded and fertrilized and is a likely candidate for mulch. On-slope BMPs, within the downgradient steep slope area, will be installed to impede surface water runoff. If SSR-3 and/or SSR-4 is the proper treatment, dozer basins will be installed to impede surface water runoff and the transition area will be seeded and planted with trees and shrubs. **Of the 22 SSR polygons, 1 has a transition area associated with it (SHOP-019.01-A).**

4.8 Construction Quality Assurance

The Uplands CQAP presents QA/QC requirements for lime placement, revegetation, storm water controls/BMPs and general requirements for work identified in this RAWP. The CQAP is provided in Appendix C of this RAWP. The Construction SWECP presents requirements to control erosion due to storm events during construction activities and also includes requirements for controlling construction-related oils, fuels and other materials. The Construction SWECP is provided in Appendix D. Additional discussion on storm water control as part the uplands RA is discussed in Section 5.0.

In-situ treatment in general involves tilling and mixing of in-place soil materials with amendment materials, as necessary, at specified application rates and mixing depths. The RA contractor shall verify that amendments (lime and fertilizer) are in compliance with the Specifications and Drawings in terms of product specifications, and that these materials are applied at the rates designated for various reclamation units, and using acceptable methodologies for calibration of equipment, incorporation, and in-place mixing. Atlantic Richfield's Oversight representative shall observe and verify the RA contractor's compliance with the Drawings and Specifications.

Atlantic Richfield's Oversight representative will perform monitoring during stockpiling of amendment materials to verify the RA contractor's compliance with location and storage protocol. Amendment materials will also be sampled periodically to verify that the material's quality complies with the requirements set forth in the FDR/RAWP and Technical Specifications. Sampling will be performed in accordance with appropriate CFRSSI SOPs.

Seeding of the revegetation areas will be monitored to ensure compliance with Specifications with regard to rate of seed and amendment application, and mulching requirements. The seedbed shall be inspected to verify it is suitable for planting. This inspection shall include verification that the soil is not too loose or overly compacted.

The following CQAP procedures may be relevant to Uplands Remedial Actions including RDU 15 – Mt. Haggin:

- Section 01000 General Procedures

- Section 01100 Record Keeping Requirements
- Section 01200 Logbooks
- Section 01210 Daily Project Logs
- Section 01400 Sample Identification and Tracking
- Section 02010 Mobilization
- Section 02110 Site Clearing
- Section 02120 Stripping
- Section 02205 Fill Material and Placement
- Section 02207 Aggregate Materials
- Section 02211 Site Grading
- Section 02212 Dozer Basins
- Section 02222 Excavation
- Section 02241 Sampling Procedures
- Section 02245 Lime Treatment
- Section 02250 Ditch Construction
- Section 02255 Grade Control Structures
- Section 02256 Check Dams
- Section 02275 Riprap
- Section 02710 Geotextiles
- Section 02751 Culverts and Piping
- Section 02900 Revegetation
- Section 02935 Brush Boxes
- Section 02936 Willow Fascines and Live Stakes
- Section 02970 Organic Amendment
- Section 02980 BMPs

5.0 SURFACE WATER REMEDIAL ACTION

5.1 Storm Water Management

Sediment and erosion control will be achieved primarily through revegetation efforts and the application of Storm Water BMPs and as necessary, implementation of engineered controls. The primary goal of the storm water BMP design effort in the Uplands RA is to develop methods to stabilize the erosion prone slopes and ephemeral intermittent

tributaries or drainages to Mill Creek as necessary in order to reduce potential COC and sediment loads in storm water runoff. Control of storm water runoff has been divided into 3 areas. These three areas include 1.) Control of storm water through Temporary Construction BMPs; 2.) Implementation of BMPs as part of the RA to control erosion/storm water runoff until vegetation becomes established and 3.) Construction of more-permanent engineered controls. The design elements are intended to reduce erosion of hillsides and drainages in order to protect the uplands remedies and reduce long-term Monitoring and Maintenance (M&M) requirements. These actions will subsequently reduce potential COC and sediment loads in the perennial streams. More information on Construction BMPs, Erosion BMPs, and engineered controls design is provided in Appendix B to the RDU 15 FDR.

The Surface Water RA has been developed to reduce erosion, promote permanent vegetation, and minimize COC runoff by employing one or more of the following BMPs, when appropriate:

1. Soil stabilization techniques such as slope grading, roughening, and serrating;
2. Grade control and check dams in tributary drainages:
3. Sediment barriers (i.e. check dams) and filters (i.e. brush boxes);
4. Minimal mulch/matting to provide temporary protection for establishment of vegetation in tributary drainages; and
5. Tilling and planting to re-establish or improve vegetation to reduce erosion.

Engineered controls have been designed and will be constructed as part of the Mt. Haggin RA. These consist of sediment ponds, with associated structures, in Muddy and Joyner Creeks and Cabbage Gulch.

5.1.1 Construction BMPs

Construction BMPs (e.g. silt fence) shall be implemented in areas of concentrated flow that could impact Mill Creek. BMPs will be implemented when construction operations are in progress in and around natural drainages. During site work activities, standard BMPs will be followed to divert storm water around the work area and to minimize storm water runoff from transporting sediments downgradient to the extent practicable. These measures may include upgradient berms, straw bale check dams, temporary ditches and/or silt fence. See the Uplands CQAP (Appendix C of this RAWP), and the Construction Storm Water Erosion Control Plan (Appendix D of this RAWP) for additional details.

5.1.2 Storm Water BMPs

Storm Water BMPs have been selected to serve as both short- and long-term sediment and erosion control measures, and to assist in natural recovery of the drainages. An assortment of BMPs (referred to herein as the “toolbox”) was developed. The intent of the BMPs is to enable the designer/field oversight to select one or more BMPs from a multitude of BMPs for use in areas of concern. The toolbox approach will enable similar design elements to be employed in each tributary, as required, and will result in increased design efficiency, construction efficiency and construction quality. Currently, the design

tool box contains numerous types of BMPs that could be employed. Each BMP is applicable and most appropriate for a certain existing condition.

BMPs proposed for use at the site have been selected to address the varied and complex conditions present in the uplands areas. Many areas of the site have limited access. Erosion control measures may be limited to BMPs that can be installed using hand labor. Furthermore, it is considered prudent to install measures that will provide temporary sediment control during construction activities as well as provide long-term sediment/erosion control and enhance the stability of the drainages. BMPs such as dozer basins in steep slope areas, check dams (all types) and log grade control structures in ephemeral drainages, vegetative buffer strips around existing drainages, and brush boxes in steep slope areas will be used to reduce downgradient sediment transport during vegetation establishment (short-term) and to protect the long-term permanence of the remedy.

Prescribed BMPs for the Mt. Haggin RA are provided on Sheet 6 of the Construction Drawings in Appendix A. Specifications and construction details for the BMPs are provided in the Technical Specifications (Appendix B) and the Detail Sheets 0.3, 0.4, 0.5 and 0.6 following Sheet 6 of the Construction Drawings in Appendix A.

5.1.3 Storm Water Engineered Controls

The engineered storm water control improvements proposed for RDU 15 are shown on Figure B.3-3 in Appendix B.3 of the RDU 15 FDR and on Sheet 6 of this RAWP and on the detail Sheets following Sheet 6 in Appendix A. The improvements include construction of 3 sediment ponds, one each in Muddy, Joyner Creeks and Cabbage Gulch, to intercept and capture sediment in runoff from approximately 3,222 acres of drainage area. Outflow from the ponds will discharge directly to Mill Creek.

5.2 Construction Quality Assurance

The Uplands CQAP presents QA/QC requirements for engineered storm water controls and storm water BMPs and general requirements for work identified in this RAWP. The CQAP is provided in Appendix C of this RAWP. The Construction SWECP presents requirements to control erosion due to storm events during construction activities and also includes requirements for controlling construction-related oils, fuels and other materials. The Construction SWECP is provided in Appendix D. Additional discussion on storm water control as part the uplands RA is discussed in Section 5.1.

The RA contractor shall verify that engineered controls/BMPs are constructed in compliance with the Specifications and Drawings in terms of product specifications and using acceptable methodologies. Atlantic Richfield's Oversight representative shall observe and verify the RA contractor's compliance with the Drawings and Specifications.

5.3 Monitoring and Maintenance

Upon completion of RA construction activities by Atlantic Richfield and its contractors, Atlantic Richfield shall be responsible for maintaining the integrity of the storm water control structures in accordance with the Final Monitoring and Maintenance (M&M) Plan.

6.0 GROUND WATER REMEDIAL ACTION

The ARWW&S OU ROD requires that long-term ground water monitoring be implemented at Waste Management Areas (WMA), Areas of Concern (AOC), and Technical Impracticability (TI) Zones.

In 1996, the EPA presented the *Ground Water Technical Impracticability Evaluation (TI) for the ARWW&S OU* (EPA, 1996). Results of this TI Evaluation revealed that arsenic concentrations exceeded the RA goals for arsenic (18 μg/L) in the bedrock ground water aquifer within portions of the Mount Haggin/Smelter Hill TI Zone (TI Zone). The EPA granted a TI waiver of the arsenic performance standard in the ROD. Performance standards for cadmium, copper, lead, and zinc are effective in the TI Zone (EPA, 1998).

The TI Zone encompasses approximately 35 square miles and RDU 15 is located primarily within the TI Zone boundary. The TI Zone southern border runs along the Mill Creek Valley and is marked by the contact between bedrock and alluvium.

No active groundwater remedial action is required for the Mt. Haggin RDU. Rather this section describes the status of ground water conditions at the RDU and the use of ICs and/or monitoring for ensuring protectiveness of human health and the environment.

As a result of the elevated arsenic concentrations within RDU 15 ground water, a long-term Ground Water Monitoring program consisting of alluvial aquifer Performance Wells (PWs) and Point of Compliance (POC) monitoring wells, bedrock aquifer performance monitoring wells, and domestic wells will be implemented. The long-term Ground Water Management Plan (AERL, 2001) attachment to the Sitewide M&M Plan describes in detail the monitoring requirements for the Mount Haggin/Smelter Hill TI Zone.

7.0 INSTITUTIONAL CONTROLS REMEDIAL ACTION

The Final Institutional Control Management Plan (ICMP) in conjunction with the selected reclamation and engineering controls will include three basic components: land use restrictions and zoning, ground water controls, and public notices or advisories.

As outlined in the ROD, implementation of the Final ICMP, as applicable will:

- *Assure that future land and water use at the site is consistent with EPA's determination of the health and environmental risks posed by contaminants left on site;*
- *Provide for the preservation and maintenance of Superfund remedial structures on the site, including but not limited to engineered caps, covers, storm water conveyances, waste repositories and reclaimed areas;*
- *Require that future development at the site employ construction practices that are consistent with the protection of public health and the environment, as determined by Superfund remedial actions and in accordance with the requirements set forth by the Anaconda-Deer Lodge County Development Permit System;*

- *If development occurs at the site, implement the remediation of soil arsenic contamination to levels appropriate for the intended use, as determined by Superfund remedial actions;*
- *Provide for implementation of other laws applicable to development, such as subdivision and floodplain requirements; and*
- *Provide information and notice to the public (users or potential users of land or ground water) of some existing or impending risk associated with their use of the site.*

Additional information related to institutional controls implemented as part of the RD for each RDU will be discussed in the Final site-wide Institutional Controls Management Plan.

The revegetation design for each RDU is based on the current arsenic land use cleanup standard, in this instance, the agricultural/open space/wildlife habitat standard of 1,000 mg/kg. Residential areas and the corresponding human health action level (250 mg/kg) are addressed under the CSOU and through the Superfund Planning Area Overlay District portion of the Anaconda-Deer Lodge County (ADLC) Development Permit System (DPS). Future development of this area may trigger sampling, development and/or remediation requirements under the SPAOD portion of the DPS.

8.0 REMEDIAL ACTION CONSTRUCTION COMPLETION

Completion of seeding will mark the end of the construction. At the end of construction a walkthrough will be scheduled with the Agencies to verify construction completion and a Construction Completion Report (CCR) will be prepared and submitted to the Agencies.

8.1 Punchlist Inspection

Upon completion of each RA, a Final Inspection Form (CQAP – Appendix C) will be completed by an Atlantic Richfield representative and an Agency representative during the walkthrough as discussed in Section 4.9.1. The form is organized by work item and requires an inspection signoff of each work item completed.

8.2 Construction Completion Report

Upon completion of each RA, a final Remedial Action Construction Completion Report (RACCR) will be prepared. The purpose of this report is to compile all construction-related information into one comprehensive document. The RACCR will include construction details, field design changes, RFCs, inspection and test results, corrective actions, photographs, As-Built drawings, QA/QC memoranda or reports and interpretations. The Report will also present the final overall project schedule, final inspection records, ARARs compliance approvals and material quantities used. This document will be submitted to the Agencies to obtain final certification and closure of the area.

8.2.1 As-Built Drawing Requirements

A master set of working construction drawings will be stored at the project trailer office. These drawings will be clearly and neatly updated to provide an “As-Built” record of all

changes and modifications to the final design and specifications, with each modification being dated and signed by the Atlantic Richfield Project representative and the Agency oversight representative. All modifications must also be clearly documented and described on an accompanying RFC form as described in Section 2.4.3. These Drawings will also be periodically copied at regularly scheduled intervals to provide a backup record, and the duplicate set will be maintained at the Atlantic Richfield's office in Butte, Montana.

Upon completion of the RA, final As-Built Drawings will be prepared for inclusion in the RACCR to document the actual lines, grades and conditions of each component of the RA. These Drawings will be based on site observations or GPS survey data, if needed, to illustrate the dimensions, identify specific locations or the layout of specific construction activities and identify compliance with the design specifications and drawings.

9.0 MONITORING AND MAINTENANCE ACTIVITIES

Upon completion of RA construction activities by the Contractor as approved by the Agencies, the integrity of the remedy shall be maintained in a manner consistent with the Monitoring and Maintenance (M&M) Plan, so as to minimize erosion or degradation of the remedy and to provide for the establishment of vegetative cover. Upon completion of the RA and achieving vegetation performance standards, as outlined in the Final M&M Plan, the landowner will be responsible for appropriate land management as outlined in the Landowner Agreement and as required under State and local ordinances.

9.1 Long-Term Monitoring and Maintenance

Once RAOs and ARARs have been achieved and documented as outlined in the M&M Plan, no additional monitoring by the PRP is required other than at 5-year reviews, as necessary.

10.0 PARTIAL DELETION

In accordance with the NCP and EPA guidance, portions of the Anaconda Smelter Site may be proposed for deletion from the National Priorities List following implementation of response actions or if the release of hazardous substances poses no significant threat to public health or the environment. The EPA's partial deletion rule, which was published in the Federal Register on November 1, 1995, allows EPA to delete a portion of an NPL site provided certain deletion criteria are met. The partial deletion rule specifically provides that petitions for delisting may be submitted to EPA by "any person, including individuals, business entities, States, local governments and other Federal agencies." 60 Federal Register 55466 (Nov. 1, 1995). Partial delisting is governed by 40 Code of Federal Regulations (CFR) 300.425(e).

11.0 REFERENCES

ADLC, 1992a. Anaconda-Deer Lodge County (ADLC) Master Plan. Prepared for the ADLC Planning Board by Robert Peccia & Associates and Lisa Bay Consulting. June 1992.

ADLC, 1992b. Anaconda-Deer Lodge County (ADLC) Development Permit System. December, 1992.

AERL 2000, Anaconda Smelter NPL Site, Anaconda Regional Water, Waste & Soils OU, Draft Surface Water Technical Memorandum, prepared by Pioneer Technical Services, Inc., July 2000.

AERL. 2001. Anaconda Smelter NPL Site, Anaconda Regional Water, Waste & Soils OU, Draft Long-Term Ground Water Management Plan. Prepared for AERL by Pioneer Technical Services. October 16, 2001.

ARCO, 1992. Clark Fork River Superfund Site Investigation Standard Operating Procedures.

ARCO, 1994. Regional Historic Preservation Second Programmatic Agreement.

Atlantic Richfield Company. 2002. Final Surface Water Technical Memorandum. Prepared for ARCO by Pioneer Technical Services. March 27, 2002.

Atlantic Richfield Company, 2007. Anaconda Smelter NPL Site, Anaconda Regional Water, Waste & Soils OU, Final Design Report, Mt. Haggin Uplands Remedial Design Unit RDU 15. October, 2007.

EPA. 1996. Ground Water Technical Impracticability Evaluation (TI) for the ARWW&S OU

EPA and MDEQ. 1998. Record of Decision, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. September 1998.

EPA, 2000. Final Remedial Design Work Plan, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. Prepared for EPA by CDM Federal Programs Corporation. June 26, 2000.

APPENDIX A.1
CONSTRUCTION DRAWINGS

Mt. Haggin Area No. 1

APPENDIX A.2
DESIGN CRITERIA SUMMARY SHEETS

Mt. Haggin Area No. 1

ANACONDA SMELTER NPL SITE
ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT

Remedial Design Unit (RDU) 1 – Stucky Ridge
Final Design Report

Atlantic Richfield Company
Butte, Montana

June 2005

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LIST OF ACRONYMS AND ABBREVIATIONS

ABA	Acid-Base Account
ADLC	Anaconda-Deer Lodge County
Agencies	EPA and MDEQ
AMC	Anaconda Mining Company
ARAR	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
ARTS	Anaconda Revegetation Treatability Study
ARWW&S	Anaconda Regional Water, Waste, and Soils
BERA	Baseline Ecological Risk Assessment
BMP	Best Management Practices
CCE	Calcium Carbonate Equivalence
CDM	CDM Federal Programs Corporation
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CGWA	Controlled Ground Water Area
CPMP	Community Protective Measures Program
CSK	Confederated Salish & Kootenai Tribes
DCR	Design Criteria Report
DNRC	Montana Department of Natural Resources and Conservation
DPS	Development Permit System
EPA	U.S. Environmental Protection Agency
FDR	Final Design Report
FRLU	Final Remedial Land Unit
IC	Institutional Controls
ICMP	Institutional Controls Management Plan
LRES	Land Reclamation Evaluation System
LT	Light Till
MDEQ	Montana Department of Environmental Quality
mg/kg	Milligrams per kilogram
mg/L	Milligram per liter
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
M&M	Monitoring and Maintenance
M-WV	Monitor – Well Vegetated
OU	Operable Unit
OM	Organic Matter
OW/EADA	Old Works/East Anaconda Development Area
PDP	Preliminary Design Package
POC	Point of Compliance
ppm	Parts per million

PRLU	Preliminary Remedial Land Unit
PRP	Potentially Responsible Party
PTSG	Planting of Trees, Shrubs, and Grasses
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAA	Remedial Action Agreement
RAG	Remedial Action Goal
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RD	Remedial Design
RDU	Remedial Design Unit
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
RRU	Reclamation Research Unit
SAP	Sampling Analysis Plan
SAR	Sodium Adsorption Ratio
SMP	Shoemaker McClean and Pratt
SSR	Steep Slope Reclamation
STARS	Streambank Tailings and Revegetation Study
TI	Technical Impracticability
TSS	Total Suspended Solids
T6	Treatment to 6 inches
T12	Treatment to 12 inches
T18	Treatment to 18 inches
USFWS	U.S. Fish and Wildlife Service
µg/L	Micrograms per Liter
WMA	Waste Management Area
WV	Well-Vegetated

FINAL DESIGN REPORT

Remedial Design Unit 1: Stucky Ridge
ARWW&S Operable Unit

1.0 INTRODUCTION

This Final Design Report (FDR) presents the design approach and basis for the Remedial Design Unit (RDU) 1 - Stucky Ridge Uplands Revegetation Design. The format of this FDR follows that presented in Attachment 1 of the Agency Comments and Revisions to the Stucky Ridge RDU 1 FDR/RAWP (EPA, 2003) and has been prepared under the July 2000 13th Amendment to Administrative Order Consent Docket NO. CERCLA-VIII-88-16 (EPA, 2000a). This design document defines the Upland Revegetation area associated with RDU 1 - Stucky Ridge and describes the site history, identifies previous reclamation work performed at the site, describes ARARs, delineates the design criteria, assumptions and considerations, provides the Remedial Design for each Stucky Ridge area requiring remediation, and outlines technical specifications and quality assurance requirements.

1.1 Site Description and History

As stated in the ARWW&S Record of Decision (ROD) (EPA & MDEQ, 1998), the ARWW&S OU covers approximately 300 square miles in the southern Deer Lodge Valley and the surrounding foothills area (Figure 6-1 of the RD Work Plan). The area consists of agricultural, pasture, rangeland, forests, and riparian and wetland areas which contain large volumes of wastes, slag, tailings, debris, and contaminated soil, ground water, and surface water from copper and other metal ore milling, smelting, and refining operations conducted on site by the Anaconda Mining Company, and its predecessors and successors, from approximately 1884 to 1980. Waste disposal occurred over approximately 6,000 acres; 13,000 acres of upland terrestrial soils are contaminated by smelter emissions; 4,800 acres of alluvial ground water contain elevated concentrations of arsenic, cadmium, and copper; and 28,600 acres of bedrock ground water exceed the State of Montana standard for arsenic (18 micrograms per liter [µg/L]).

Stucky Ridge is situated on the north side of Anaconda, Montana, between Warm Springs Creek and Lost Creek (Sheet 1). Galen Road forms the eastern boundary for this project. Soils in the area were generally impacted by smelter fallout from the Washoe and the Upper and Lower Works Smelters. The Smelters began operations in approximately 1884 and continued until September 1980.

1.2 Site Setting

1.2.1 Climate

Anaconda has a semi-arid climate characterized by cold winters, relatively cool summers, light precipitation, and moderate winds. The average annual precipitation measured at the East Anaconda weather station for the period of 1951 through 1974 was 13.7 inches, while the average evaporation occurring between April and November (measured in 1974 and 1978) was

48.9 inches. Approximately two-thirds of the average precipitation occurs between April and September, with approximately one-half of this amount occurring during May and June (Tetra Tech, 1987).

1.2.2 Topography

Ground elevations within the Stucky Ridge site range from approximately 5,070 to 5,500 feet above mean sea level. In general, topography within the site varies from moderate hills and very steep slopes to a flatter valley floor. Soil thickness within the site is highly variable consisting of little or none in areas of bedrock outcrops, very gravelly in many of the steeper sloped hillside areas to several feet thick in many areas.

1.2.3 Current Vegetation

Current vegetation conditions within the site vary from sparse to well vegetated based on the Land Reclamation Evaluation System (LRES) Phase II performed by both the Montana Department of Environmental Quality (DEQ) and the U.S. Environmental Protection Agency (EPA) (the Agencies) and Atlantic Richfield. Well vegetated areas are considered to meet the remedial action (RA) goals of minimizing wind and water erosion, reducing infiltration and providing wildlife habitat. Natural recovery of vegetation has occurred in many areas of the site and will continue in the future. The well vegetated areas include primarily grasses (redtop, Great Basin wild rye, Bluebunch wheatgrass and Indian ricegrass) and shrubs (sagebrush, rabbitbrush and horsebrush).

1.2.4 Geology

Six distinct units characterize the local geology surrounding the east end of Stucky Ridge, and are comprised mostly of sandstones and volcanics. The oldest formation, the Elkhorn Volcanics, is represented by two units: basalt and coarse white tuff. Above the Elkhorn Volcanics is the Renova Formation, a member of the Bozeman Group. It is a fine to medium grained sandstone believed to have been deposited on a low energy flood plain. The Lowland Creek Volcanics are represented by a volcanic breccia unit and a welded tuff unit. Stratigraphically above the tuff lies a quartzite rich diamicton Quaternary in age and interpreted as a braided stream deposit. The unit is informally named the Old Works Diamicton. It has a maximum thickness of 60 meters, with a well developed organic horizon and caliche layer comprising the upper half meter to meter. The unit is unconsolidated, unstratified, and matrix supported with well-rounded clasts ranging in size from pebbles to boulders. In general, the matrix is a light tan sandy clay loam; in some locations it is more sandy, while in others it has more clay (Lethenstrom, 1997).

1.2.5 Hydrogeology

Both a bedrock aquifer and an alluvial aquifer underlie the East Stucky Ridge area. The bedrock aquifer underlies the steep hill slopes of Stucky Ridge, and the alluvial aquifer is located along the valley floor of Warm Springs Creek and Mill Creek. The bedrock aquifer contained within competent volcanic rock has characteristically low permeability and is generally dominated by fracture-controlled flow. By contrast, the alluvial aquifer is very permeable and is comprised of unconsolidated alluvial materials in which ground water flows through intergranular pores.

1.2.6 Hydrology and Hydraulics

Surface water hydrology and measures for control of storm water runoff have been studied and presented in the *Final ARWW&S Remedial Investigation (RI)* (ARCO, 1996) and the *Final Conceptual Storm Water Runoff Control Plan (CSWRCP)* (AERL, 1999a) for use in the ARWW&S Remedial Design (RD).

Drainage off of the north side of Stucky Ridge flows into an existing storm water ditch which runs along the south side of the Lost Creek Highway. Flows in this ditch are conveyed east across Highway 273 and into Gardiner Ditch. Gardiner Ditch drains into Lost Creek approximately 1/2 mile north of this junction.

Field reconnaissance in August, 2003 revealed that an existing culvert under Lost Creek Highway drains a large portion of the watershed previously thought to have stayed on the south side of the highway. Approximately 3 square miles of drainage area previously included in the hydrologic calculations for the north side of Stucky Ridge actually drains across the Lost Creek Highway, to Lost Creek, rather than to Gardiner Ditch.

Current drainage off the east end of Stucky Ridge is directed east, into Gardiner Ditch. The Ditch conveys flows north to Lost Creek.

1.2.7 Wetlands, Floodplains, Threatened and Endangered Species

Several areas within the ARWW&S OU have been delineated as wetlands. *ARWW&S OU Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area;* (AERL, 1999b). Delineated wetland areas within RDU 1 are shown on Sheet 4. There are no known endangered species within the project boundary. It is anticipated that reclamation activities will have minimal impact to identified wetlands.

1.3 Final Design Report/Remedial Action Work Plan Organization

Stucky Ridge is one of 15 RDUs that were identified in the ARWW&S OU Remedial Design Work Plan (RDWP). The West Galen area was added to the ARWW&S OU as an expansion area following sampling and investigation activities conducted by the Agencies that identified smelter-related impacts. A Final Design Report (FDR) and a Remedial Action Work Plan (RAWP) will be prepared for each RDU. The Stucky Ridge RDU has been divided into four separate design areas based on topography, hydrology and treatment areas. All four design areas are addressed by the Stucky Ridge FDR and RAWP.

Several supplemental site-wide remedial design/remedial action (RD/RA) Management Plans affect the implementation of the remedial action (RA) for Stucky Ridge. These site-wide documents are as follows:

- Site Management Plan
- Institutional Controls Management Plan
- Monitoring and Maintenance Plan

The Final Design Report/Remedial Action Work Plan (FDR/RAWP) for Stucky Ridge (Atlantic Richfield Company, 2005a) has been organized into the following two parts:

- **Part I** presents the FDR. This report provides the remedial action objectives (RAOs), Selected Remedy, and remedial requirements of the ARWW&S OU ROD, summarizes the results of design investigations and analyses that have been completed since the ROD; presents the basis of design for each remedial design component (soils, surface water, ground water, and institutional controls), and identifies key design criteria and performance standards, summarizes the existing data, discusses and evaluates remedial alternatives evaluated during the design, and presents the final design and drawings (scales of 1"=500', 1"=600', 1"= 750' and 1"=1000'). An analysis of how the design is expected to achieve RAOs is presented in the FDR.
- **Part II** presents the RAWP. This work plan identifies project roles and responsibilities; procedures to implement the RA; specifications, a quality assurance plan, and construction drawings (scale of 1"= 500'); pre-construction activities; construction tasks; monitoring, inspection, and maintenance requirements. Stucky Ridge has been divided into 4 RA Work Plan areas.

This FDR for RDU 1 - Stucky Ridge Revegetation Design includes approximately 3,888 acres of remedial polygons (see attached Sheets). Approximately 2,256 acres of these polygons require implementation of a remedial action while the remaining approximately 1,632 acres do not require physical remediation (i.e. treatment) as they are facilities or are well vegetated and may only require monitoring/weed spraying at this time. Approximately 153 acres of RDU 1 were previously reclaimed as part of demonstration projects implemented by Atlantic Richfield and/or the Agencies and an additional 224 acres within Stucky Ridge Area No. 4 were remediated by Atlantic Richfield in 2002/2003.

Seven sheets illustrating elements of the Remedial Design are included with this FDR. These elements include physical features, data locations, land ownership, land use, the ground water remedy, surface water controls/BMPs and the soils remedies. In addition, BMP detail drawings are included. Also, attached to this FDR is the Summary of Design Calculations (see Appendix A).

1.4 Purpose and Objectives of the Final Design Report

The purpose of this Final Design Report is to provide the design data, logic, remedial alternatives, design analyses and drawings for the RDU 1 Revegetation Design. The Revegetation Design is based on criteria provided in Section 2.4.1 to meet the Remedial Action Objectives for each media within RDU 1 as defined in the ARWW&S OU Record of Decision.

1.5 Final Design Report Organization

This Final Design Report has been organized into the following sections:

- Section 1 is an introduction to this report for Stucky Ridge, identifies the purpose and objectives of this report, and lists the organization of the Final Design Report/Remedial Action Work Plan;
- Section 2 provides the remedial design for soils including design alternatives, design analysis and monitoring and maintenance;

- Section 3 provides the remedial design for surface water including design alternatives, design analysis and monitoring and maintenance;
- Section 4 provides the remedial design for ground water including design alternatives, design analysis, and monitoring and maintenance;
- Section 5 provides the remedial design for institutional controls including design alternatives, design analysis and monitoring and maintenance;
- Section 6 provides the references cited in this report.

2.0 SOILS

Remedial Action Objectives for impacted soils will be met through the reduction of arsenic to the applicable standards and/or the reestablishment or improvement of vegetation which may include the use of in-situ treatment of soils (tilling), vegetation enhancement and natural recovery. It will also include implementation of surface water controls/BMPs in steep slope areas. Remediation technologies have been selected based on arsenic and other COC concentrations, land use, topography (slopes steeper than 3H:1V), soil pH, lime rate requirements and rock content. Remedial design alternatives, final remedial designs, design analysis and monitoring and maintenance for RDU 1 are discussed in this section.

2.1 Impacted Soils Remedial Action Objectives

As stated in Section 10.2 of the RDWP (EPA, 2000b), Remedial Action Objectives for impacted soils within the ARWW&S OU that are applicable to the RDU 1 RD presented in this FDR include:

- "*Provide a permanent vegetative cover over contaminated soil material to prevent direct contact with arsenic, thus reducing the potential risk of human exposure to acceptable risk-based levels;*
- *Provide a permanent vegetative cover over contaminated soil material to minimize transport of COCs to ground water, which cause exceedances of ground water ARARs set forth in Appendix A of the ROD;*
- *Provide a permanent vegetative cover over contaminated soil material to minimize surface water erosion and COC transport to surface water in excess of surface water ARARs set forth in Appendix A of the ROD;*
- *Provide a permanent vegetative cover over contaminated soil material to minimize wind erosion and movement of COCs onto adjacent lands, thus preventing risk of human and wildlife exposure;*
- *Reduce surface COC levels to allow re-establishment of vegetation, thus reducing risk to upland terrestrial wildlife above risk-based levels and allow re-establishment of wildlife habitat; and*
- *Remediate contaminated soils to be compatible with the existing and anticipated future land use with minimal future maintenance activities."*

2.2 Impacted Soils Remedial Requirements

As defined in the ROD and RDWP relevant Remedial Requirements for impacted soils for the ARWW&S OU that are applicable to the RDU 1 RD presented in this FDR include:

- *Reduce arsenic concentrations at the surface to below 1,000 ppm,* 500 ppm (as appropriate), *and 2,500 ppm in the Smelter Hill subarea, as appropriate, using a combination of revegetation treatment techniques.*
- *Revegetation techniques, which may include deep tilling with lime additions and soils amendments, to reduce surface soil arsenic concentrations to below 1,000 ppm* (2,500 ppm on steep slope areas in the Smelter Hill RDU*) and establish a diverse, effective, and permanent vegetation cover.*
- *Apply revegetation technologies to establish a self-sustaining assemblage of plant species capable of:*
  - *Stabilizing the soils against erosion and minimizing transport of contaminants to surface and ground water in order to meet water quality standards as set forth in Appendix A [of the ROD document].*
  - *Maximizing water usage.*
  - *Re-establishing wildlife habitat.*
  - *Accelerating successional processes.*
- *Apply BMPs for agricultural lands, as appropriate.*
  - *BMPs currently adopted or to be developed for various individual lands will be reviewed and included in the site-wide ICs Planning Document.*
  - *For barren/sparsely vegetated areas determined to be a source pathway to surface water, revegetation will accomplish storm water objectives, including application of BMPs.*
- *Use ICs to maintain the integrity of remedial actions and prevent exposure to contaminated soil.*
  - *Apply ICs, appropriate for land ownership and land use, capable of maintaining and protecting revegetated lands.*
  - *Maintain existing ICs (e.g., governmental trespass and zoning regulations) to restrict access as needed.*
  - *Use the ADLC DPS process on lands proposed for new land use and which would require additional soil remediation, if necessary.*
- *Provide for O&M activities as necessary to:*
  - *Inspect the conditions of revegetated lands and IC remedies.*
  - *Repair revegetated lands and structures, as needed.*
  - *Develop specific procedures for O&M during remedial action for final implementation at the time of construction completion of selected areas.*

2.3 DESIGN DATA

2.3.1 Existing Data Summary

Significant data exists on the soil characteristics within RDU 1. Applicable data was collected during the following referenced sampling events: various sampling events primarily associated with development of the Remedial Investigation and Feasibility Study (RI/FS); the LRES Phases II and III sampling, LRES Phase III Addendum Nos. 1 and the Outer Boundary Delineation sampling. The soils collected during these sampling events were analyzed for COC concentrations and/or pH (see Appendix A and Sheet 2).

RI Data

Data collected and used in development of the RI (ARCO, 1996) for ARWW&S OU is stored in the Clark Fork Data Management System (CFDMS) database. This information includes historic arsenic, metals, pH and other soils data from the following referenced data transmittals: ARCO 1994; Ashe 1994; CDM 1987 and 1988; DynCorp-Viar 1994; MSU 1993; MSE 1996; PTI 1991, 1992, 1993; and Tetra-Tech 1986. A summary of the data collected during these investigations is located in the data tables in Appendix A and Sheet 2 of the drawings.

LRES Phase I, II and III

The Land Reclamation Evaluation System (LRES) was developed for the EPA to provide a preliminary identification of land reclamation approaches and the intensity levels appropriate for impacted soils within the ARWW&S OU based on vegetation cover. In 1997 the Agencies developed the concept for LRES and performed field calibration and developed the scoring system (LRES Phase I) based primarily on vegetation cover. Vegetation cover data based on LRES were used to determine the degree of natural recovery and/or if vegetation cover was sufficient such that remedial action was or was not required. In 1998, a field reconnaissance program was conducted on more than 12,500 acres of potentially impacted soils at the site. As previously mentioned, the area was subdivided into polygons based primarily on vegetation conditions, soil erosion and arsenic concentrations. Based on this work and historic data, preliminary land reclamation remedial alternatives were assigned to each of the polygons. Evaluation of the LRES Phase II report suggested that additional field data were required in order to refine proposed remedial actions.

In 1999, the EPA approved plan for LRES Phase III Sampling and Analysis was conducted. In addition to refining the proposed remedial activities, the data collected during the Phase III sampling was used to augment existing data to further subdivide polygons into subpolygons and as a Remedial Design tool. The soil samples collected during the LRES Phase III evaluation included analyses for arsenic, copper and zinc concentrations, rock content, pH and liming requirements. A summary of the data collected during the LRES Phase III is provided in Appendix A of this FDR. Sample locations are also shown on Sheet 2 of the Drawings.

LRES Phase III Addendum No. 1

In 2001, the EPA approved LRES Phase III SAP Addendum No. 1 for sampling the West Galen area and filling data gaps identified in the PDPs and Agency comments to the PDPs. This effort included the collection of samples from 83 locations. The soil samples collected during the LRES Phase III Addendum No. 1 evaluation included analyses for arsenic, copper and zinc

concentrations, rock content, pH and liming requirements. A summary of the data collected is provided in Appendix A of this FDR. Sample locations are shown on Sheet 2 of the drawings. In 2004, sampling was approved under the LRES Phase III Addendum No. 1 (Supplement No. 2) to fill data gaps in the West Galen and Fluvial Tailings Expansion areas, as well as within RDUs (Stucky Ridge, Lost Creek, North Opportunity and South Opportunity).

Operable Unit Outer Boundary Delineation

During spring 2000, the agencies conducted additional sampling to delineate the outer boundaries of the ARWW&S OU. Sampling was conducted using similar protocols to those used during the LRES Phase III evaluation. These data are provided in the *Data Summary Report – Delineation of Outer Boundary* (MDEQ & EPA, 2000).

2.4 Final Design

The remedial design for impacted soils includes evaluation of various treatment alternatives and soil data to develop a design that meets the ARWW&S OU performance standards and ARARs. The following section presents the approach used to identify impacted areas and presents the design criteria, describes the design process and logic and identifies the treatment alternatives selected by polygon. Several design examples are also provided to help the reader understand the process used to develop the designs.

Attached to this Final Design Report are Drawings detailing the RDU 1 area (Sheet 1 aerial base), the data and pre-remedial action surface Arsenic (As) concentrations (Sheet 2), the land ownership boundaries (Sheet 3), land use (Sheet 4), ground water remedy (Sheet 5), storm water controls (Sheet 6), and soil remedies and calculated As concentrations based on post-tilling reduction (Sheet 7). In addition, several design drawings supplement Sheet 6 (Storm Water Controls/BMPs) and provide the detailed design for engineered storm water controls (i.e., sediment basins and drainage channels).

This section identifies the following:

1. Design Criteria – standards that the design must meet through design and as demonstrated through a construction quality assurance program.

2. Design Process – identifies the process in developing the design based on the design criteria

3. Design Assumptions – represents a premise that the design is based upon that is later proven-out through completion of data collection and/or application of the Design Logic.

4. Design Constraints – places limitations that the design must work within.

5. Design Considerations – a premise or tenet that should be given attention to during the design process and should factor into the remedial design decision process.

6. Data Gaps – additional data required to determine remedial requirements for an impacted area requiring remediation.

7. Design Alternatives – a description of the various alternatives that were evaluated for implementation during the design process.

8. Design Logic/Alternative Evaluation – a description of the design logic that was administered to select the remedial alternative.

9. Design Examples – examples of application of the design process and criteria using actual design data to determine the remedial requirements for a given area within RDU 1.

2.4.1 Design Criteria

Criteria used in identifying impacted Upland areas:

Human health Arsenic action levels – 1,000 mg/kg for open space/agriculture/recreation, and 500 mg/kg for commercial/industrial areas.

LRES score – 115 or vegetation cover – 30% (per the RDWP, see Table 4). This applies to Upland areas other than steep slope areas.

2.4.2 Design Process

Data were collected through various sampling events (See Section 2.3) to determine the appropriate design for impacted areas. These data primarily included soil COC concentrations and LRES/vegetative cover. Soil pH, acid base accounting and rock content were also collected in the field when other data were being collected or during polygon delineation. The COC data were compared against the human health criteria to determine if soil mixing was required or adequate to reduce the arsenic concentration to meet human health criteria. Vegetation cover data, based on LRES were used to determine the degree of natural recovery and/or if vegetation cover was sufficient such that remedial action was or was not required. Soil pH, ABA and rock content were obtained to assist in determining actions required to establish vegetation.

Upon identification of impacted areas requiring remedial actions based on soil arsenic concentrations and/or vegetation cover (LRES), polygons were evaluated to determine an appropriate remedy. Evaluation of the upland remedial alternatives and selection of an appropriate remedial action was based on slope steepness, existing vegetation cover, soil pH, arsenic concentrations and land stewardship within a polygon. Slopes steeper than 3H:1V provide safety concerns and implementability issues. The remedy chosen for these areas is SSR. Areas with higher vegetation cover (i.e. 25 to 30 percent cover or LRES close to or greater than 115) generally result in selection of a less intensive remedial action such as Monitoring-Well Vegetated or Well Vegetated as these areas should be able to achieve the performance standards through less intensive forms of vegetation enhancement (i.e. weed spraying). In areas where the action levels are exceeded (arsenic concentrations greater than 1,000 mg/kg or 500 mg/kg, where appropriate) and/or the vegetation cover is less than 30% (LRES score less than 115) the area will be tilled and amendments added, as necessary.

In order to make the above determinations the remedial design approach evolved into a three-step process as follows:

1. LRES Phase II field evaluations and polygon (PRLU) designation,

2. LRES Phase III soil sampling and evaluation of the data against the design criteria; and
3. Resolution in the field by representatives of Atlantic Richfield and the Agencies.

Step 1 of the design process consisted of the evaluations performed under LRES Phase II. This work included site reconnaissance by Atlantic Richfield and Agency team members and observation of site conditions including vegetation cover, potential for COC transport and preliminary remedy determinations. The intent of the LRES Phase II investigation was to identify a preliminary remediation requirement based on vegetation cover (LRES score – Preliminary Remedial Land Units). A detailed description of the work performed and results are presented in Land Reclamation Evaluation System Phase II Report (CDM & RRU, 1999).

Step 2 of the design process further refined the evaluations made in LRES Phase II. This step (LRES Phase III) included collecting soil samples and evaluating soil COC concentrations, soil pH, ABA, rock content and the existing vegetation cover. The intent of this step was to refine the remedial action and the intensity necessary within a PRLU. During this step, PRLUs were further divided into polygons and subpolygons. The basis for determining whether remediation is required is based on average COC concentrations as they relate to the human health action level for arsenic and the establishment of vegetation. The associated land use arsenic action level for these areas is 1,000 mg/kg and in limited areas 500 mg/kg. In addition, existing vegetation cover was utilized to evaluate the severity of impacts, the degree to which natural recovery is occurring and the intensity of any proposed remedial action. The basis for determining the intensity of treatment was generally based on the magnitude of arsenic concentrations as well as other COCs and the need for soil amendments to establish a suitable growth medium.

Step 3 of the design process included Agency review of the remedies prepared by Atlantic Richfield and submitted in the PDPs. Areas of remedy disagreement were identified and mapped. Representatives from Atlantic Richfield and the Agencies then performed field evaluations of the areas of disagreement to determine the appropriate remedial approach (i.e., treatment, steep slope, monitoring, etc.). Further evaluation of the data, and in some instances additional data collection, was used to determine the intensity of the remedial alternative (i.e., T6, T12, etc.). Sheet 7 of this FDR present the results of these evaluations

2.4.3 Design Assumptions

Design Assumptions, as defined by the Agencies are any issue that *"represents a premise that the design is based upon that is later proven-out through completion of data collection and/or design analyses."* Development of the design for RDU 1 – Stucky Ridge includes the following assumptions:

- In-situ treatment is appropriate for impacted soils provided that the human health action level for arsenic of 1,000 mg/kg or 500 mg/kg, where appropriate, can be achieved;
- Treatment in open space/agricultural areas is not required, if LRES scores are close to or greater than 115 and arsenic values are less than 1,000 mg/kg;
- No remedial action is required, other than monitoring, if LRES scores are greater than 115 and arsenic levels are less than 1,000 mg/kg;

- Treatment in commercial/industrial areas is not required if arsenic levels are less than 500 mg/kg;
- Vegetation impacts in some areas are not smelter related but are related instead to land management practices (i.e., overgrazing)
- Remediated areas do not require mulching and/or BMPs unless potential for significant erosion is demonstrated;
- The soil pH target for impacted soils in areas amended with lime is 7.0; and
- A standard fertilization rate is adequate for all areas unless an alternate application is specifically identified.

2.4.4 Design Constraints

The Agencies have defined Design Constraints as any item that *"places limitations that the design must work within."* The following design constraints have been identified:

- Safety on steep slopes limits remedial activities that can be implemented
- High rock content in some areas limits certain remedial action (i.e., tillage);
- Weed control will be required in some areas prior to remediation;
- Private ownership and land uses may limit certain remedial actions; and
- Historic structures will be maintained where practicable.

2.4.5 Design Considerations

The Agencies define Design Considerations as "*a premise or tenet that should be given attention to during the design process and should factor into the remedial design decision process.*" The following design considerations will be made with regard to the RD for RDU 1:

- Wetland locations will be avoided to the extent possible and mitigation of wetlands where impacted;
- Current and Future Land Use practices;
- Soil amendments such as high phosphorous fertilizer and organic matter may be used in some areas based on site specific factors;
- Seed specifications will comply with remediated land use and will not necessarily implement a diverse plant community if land use does not require such diversity (i.e., grazing);
- Seeding in the fall is preferable, but may be performed either in the fall or early spring depending on completion of construction activities and weather;
- Direct remediation of ground water is not a component of the RA for this RDU; and
- Remediation of impacts within residential areas will be performed under the CSOU and/or the ADLC DPS.

2.4.6 Data Gaps

It is not anticipated that significant additional data will be required to finalize design components for areas within RDU 1. Field inspections are necessary prior to construction, which may require some sampling and analyses to determine COC concentrations at depth in order to confirm estimated post RA arsenic concentrations. Some limited vegetation assessments are required in some polygons to determine whether vegetation is present and confirm the prescribed remedial action. In addition, prior to implementation of the remedy, an assessment of the A-horizon in areas where tillage is prescribed will be performed to determine organic matter requirements.

2.4.7 Remedial Design Alternatives

Once an impacted area has been determined to require some form of remedial action, several design alternatives are evaluated based on slope steepness, the magnitude and depth of COC concentrations that exceed the human health action level and COC concentrations and soil amendment(s), if necessary, to provide a suitable growth medium. The following techniques represent the range of remedies that were evaluated in the RDU 1 design. The design logic and alternative evaluation are presented in Section 2.4.8; data are summarized in Table A-1, Design Criteria Summary Tables, and Table A-2, Data Summary. Applicable Specifications and CQAP Procedures are referenced in the following sections. The Upland Technical Specifications and CQAP are attached to the RDU 1 RAWP. These remedial alternatives are intended to achieve the desired remediation goal of a self-sustaining stand of vegetation meeting the performance standards identified in the Final M&M Plan. Remedial alternatives identified below include a comprehensive list of the alternatives that were considered in development of the FDR. Alternatives that will not be implemented in the area addressed by this FDR are still identified and are noted as such.

2.4.7.1 Soil Treatment

2.4.7.1.1 T18 (Tillage to 18 inch depth).

Tillage to 18 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels in soils cannot be reduced to less than the relevant action level through T6 or T12. This technique is limited in application and is applicable to deeper depths of soil contamination. Tillage of soils to an 18-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 18 inches will reduce metals concentrations by mixing the upper soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T18 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7. Lime rates and associated calculations for areas requiring lime are provided in Table A-3. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 18 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval, and greater than 6.0 s.u. in the 6 to 12 or 12-18-inch interval.

Following implementation of the T18 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been

previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation, as identified in the field and/or preconstruction site walkthrough, will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). 1.5% OM will be added to all T18 areas, and will be incorporated into the 0-6 inch interval. **There are currently no T18 areas within RDU 1**.

2.4.7.1.2 T12 (Tillage to 12 inch depth).

Tillage to 12 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels in soils cannot be reduced to less than the relevant action level through T6. Tillage of soils to a 12-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 12 inches will reduce metals concentrations by mixing the upper soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T12 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7. Lime rates and associated calculations for areas requiring lime are provided in Table A-3. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 12 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval, and greater than 6.0 s.u. in the 6 to 12-inch interval.

Following implementation of the T12 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation, as identified in the field and/or preconstruction site walkthrough, will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. Following tillage, Polygon OWSR-004.04, approximately 36 acres, will receive 6 inches of coversoil from an approved borrow source and shall then be fertilized and seeded. **There are approximately 918 acres of T12 within RDU 1**.

2.4.7.1.3 T6 (Tillage to 6 inch depth).

Tillage to 6 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels are located in the upper soil layer. Tillage of soils to a 6-inch depth will be accomplished by use of agricultural implements (i.e.

Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 6 inches will reduce metals concentrations by mixing the surface soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T6 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7. Lime rates and associated calculations for areas requiring lime are provided in Table A-3. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 6 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval.

Following implementation of the T6 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation, as identified in the field and/or preconstruction site walkthrough, will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. Following tillage, Polygon OWSR-004.02, approximately 8 acres, will receive 6 inches of pit run gravel. This area is a Facility-Junk Yard (acreage is not included in T6 acreage total) and will continue to be operated as a Facility-Junk Yard. Tillage to 6 inches is required to reduce arsenic concentrations to less than 500 mg/kg. **There are approximately 706 acres of T6 within RDU 1**.

2.4.7.1.4 LT (Light Tilling 2 to 4 inch depth).

Those areas that contain low surficial impacts will be remediated with a light tillage of surface soils with possible lime amendment. No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) in the 0 to 6-inch interval is greater than 6.5 s.u. The goal of this remediation approach is to maintain existing vegetation while improving the conditions, primarily soil pH, of the existing seedbed for enhancement of existing vegetation. Equipment utilized for implementation of the light tilling remedy will primarily consist of standard agricultural equipment (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Similar to the T6 remedial alternative, implementation using standard farm equipment will result in some variability in implementation with tillage depths generally ranging from 2 to 4 inches. If lime amendment is required, it will applied at the 0-6" lime rate with no pre-till required. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring LT are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7, however post tillage QA is not required. Lime rates and associated calculations for areas requiring lime are provided in Table A-3. Following the light tillage the area will be fertilized and drill seeded using a standard fertilizer rate using an upland seed mix, consisting of species that have been previously demonstrated as successful at

other remediation projects and fertilized (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation) or other mix as modified by the landowner. It is not anticipated that organic matter amendment will be necessary within areas remediated with light tillage. **There are no LT areas within RDU 1**.

2.4.7.1.5 Stripping (Stripping of Highly Impacted Surface Soils)

Those areas that contain highly impacted soils created by fluvial deposition and/or windblown tailings may include remediation via stripping and consolidation of highly impacted surface soils followed by tilling of the underlying subgrade, as required, to achieve the human health arsenic action level of 1,000 mg/kg or 500 mg/kg where appropriate and to provide a soil layer suitable for establishing and sustaining plant growth (See Technical Specification Section 02120 – Stripping and CQAP Sections 02010 – Mobilization and Section 02120 – Stripping). The required depth and horizontal extent of removal will be determined on a polygon basis, from soils data and field evaluation. Following stripping of the upper soil layer, the subgrade soil shall be evaluated to determine whether tilling and amendment addition is necessary to reduce soil COC concentrations and/or provide a suitable growth medium. Based on data following stripping, no lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval and greater than 6.0 s.u. in the 6 to 12-inch interval. If an area requires lime addition and incorporation, the area will be pre-tilled one time to a depth of 6 or 12 inches, based on post soil stripping data to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). Stripped materials will be consolidated in a WMA. Cleared and grubbed vegetation will be disposed of or used, as appropriate, for erosion control (i.e., log check dams, brush boxes).

Following stripping of the surface materials, amendment application and tilling, as necessary, the area shall be seeded using the standard upland seed mix, or the riparian seed mix in riparian areas, and fertilized (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation). The use and need for organic matter amendment of soils within areas remediated via Stripping will be evaluated on a polygon-by-polygon basis (See Section 2.4.8.5). Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. **There are no areas targeted for Stripping within RDU 1**.

2.4.7.1.6 SSR (Steep Slope Reclamation).

Steep slope areas are identified by a slope steeper than 3:1 (vertical to horizontal). The RDWP identifies 4 types of SSR. The techniques to be implemented for SSR are:

1. SSR-1 - Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs;
2. SSR-2 – Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs that do not require mechanized equipment (e.g., brush boxes, straw bales, wattles, check dams and other BMPs);

3. SSR-3 – Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins); and

4. SSR-4 – Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins), and slope regrading/recontouring.

For design and implementation purposes, the design drawings illustrate SSR remediation as specific activities or engineering controls, but the maps show only general locations and techniques to be implemented. Actual locations and SSR techniques will be determined in the field based on site-specific conditions. **There are approximately 631 acres of SSR within RDU 1.**

Woody Species Selection and Location for SSR Treatment

Trees and shrubs shall be planted on side-slopes of steep sloped areas to help stabilize the soil, reduce runoff velocity and to encourage establishment of woody species. To help reduce erosion and reduce runoff from the steep slope areas, on-slope BMPs (i.e., brush boxes, dozer basins) will be constructed, as appropriate. Woody species shall be planted in conjunction with the on-slope BMPs to help reduce soil erosion, increase evapotranspiration and re-establish vegetation on the side-slopes. Specification 02930-Planting of Trees and Shrubs provided as an Appendix to the RDU 1 RAWP identifies a comprehensive species list for PTSG plantings. Suggested species for the polygons within the project area primarily include chokecherry, currant and Woods rose as well as Rocky Mountain juniper, limber pine, Douglas-fir, Lodge pole pine and ponderosa pine. Chokecherry and currant will be concentrated in transition zones, (i.e. base of slopes or concave depressions and east/north facing slopes). Rocky Mountain juniper, limber pine, Douglas-fir, Lodge pole pine and ponderosa pine will be planted on other slopes. Woods rose will be concentrated on the lower portion of the slope on both warmer and cooler aspects to aid in soil stabilization. The planting density for trees and shrubs in the Upland areas is 450 stems per acre, plus an additional 50 trees/shrubs per acre following remediation. The additional 50 trees/shrubs would be planted within 10 years of initial planting and meets the requirements for monitoring and maintenance for steep slopes. In conjunction with planting of trees and shrubs, SSR areas will be broadcast seeded using the Seed Mix 6 at a seeding rate of approximately 25 pounds per acre. This seed mix is identified in Specification 02940-Seeding, an Appendix to the RDU 1 RAWP.

To the extent possible during planting of woody species on side-slopes, small depressions or basins around the plantings will be created to help retain surface water and provide additional runoff control. In areas where planting of trees and shrubs is implemented in conjunction with brush boxes and dozer basins, these BMPs will help retain surface water.

2.4.7.1.7 Transition Zones

The Transition Zone is defined as the area between an upgradient hillside or hilltop (flatter than 3H:1V) treatment area (i.e. T6, T12, LT) where treatment ends due to slope steepness and the downgradient steep slope (as previously defined) located below the treatment area. Because vegetation in treatment areas may not be fully established for several years following treatment,

it is necessary to construct temporary storm water BMPs to minimize potential erosion and sediment transport from the upgradient treatment area to the slope below. Although tillage equipment may not be able to operate safely in the Transition Zone, track-type tractor equipment such as dozers may be able to operate safely until the steepness of the slope exceeds 2H:1V as determined in the field. At the transition zone, if tillage is unable to extend to the start of the SSR area, dozers may be used to construct temporary BMPs such as dozer basins and temporary along-contour ditches, and to grade erosion rills and gullies, as determined in the field by construction oversight personnel. Areas of adequate existing vegetation or rock outcrops will be avoided. While Transition Zones are identified on Sheets 6 and 7 as linear zones between treatment polygons and steep slope reclamation polygons down slope of the treatment areas, the width of the transition zone is unknown and will ultimately be determined during construction when the tillage limits become known. Transition areas are only applicable to SSR polygons with a remedy of SSR-1, SSR-1/SSR-2, SSR-2, SSR-2/SSR-3, and SSR-3 with an adjacent upgradient tillage polygon.

If a transition area is able to be tilled it will be seeded and fertilized and is a likely candidate for mulch. On-slope BMPs, within the downgradient steep slope area, will be installed to impede surface water runoff. If SSR-3 and/or SSR-4 is the proper treatment, dozer basins will be installed to impede surface water runoff and the transition area will be seeded and planted with trees and shrubs.

2.4.7.2 Monitoring Areas

Polygons identified as "Monitoring" include well vegetated areas (Vegetation Cover 30% or greater and/or LRES score greater than 115.), monitor well vegetated (M-WV) areas (Vegetation cover in the range of 25%-30% and/or LRES score close to 115), rock outcrops and certain developed areas (facilities, rock quarries, historic features, gravel pits, etc.) and previously reclaimed areas Although these polygons have been designated as monitoring under LRES, there is the potential that some portions of these polygons will require an action (i.e. weed spraying or treatment of barren areas). The converse is also true. Treatment polygons that contain rock outcrops or well-vegetated areas do not require tillage. Monitoring areas require monitoring under the Final Monitoring and Maintenance Plan (Vegetation Management Plan).

2.4.7.2.1 WV (Well Vegetated)

Acreage that exhibits healthy stands of vegetation and is below the appropriate human health arsenic action level does not require implementation of a treatment action (tillage) and is termed well vegetated. These areas typically have exhibited vegetation cover of 30 percent or greater and/or an LRES score greater than 115. These areas have met or exceed performance standards. These areas will be monitored using methods and procedures for vegetation monitoring activities identified in the Vegetation Management Plan. **There are no WV polygons within RDU 1.**

2.4.7.2.2 M-WV (Monitoring – Well Vegetated).

Significant acreage within RDU 1 exhibits vegetation that does not currently require implementation of a treatment action (i.e., tillage). These areas typically exhibit vegetation cover in the range of 25 to 30 percent and/or an LRES score close to 115. These areas will be monitored throughout implementation of remedial actions in adjacent areas and during post-

remedial action monitoring of remediated areas as outlined in the VMP. These monitoring activities may include confirmatory sampling and analysis, qualitative assessments, failure evaluations, and trend analyses. Detailed methods and procedures for monitoring activities are identified in the Vegetation Management Plan (Atlantic Richfield Co., 2005b, In Progress). **There are approximately 996 acres of M-WV areas within RDU 1.**

2.4.7.2.3 Facilities (i.e Gravel Pits, Historic and Agricultural Areas)

Certain areas within RDU 1 do not require remediation based upon current or historic use (e.g. development, facilities, gravel pits, historic areas and agricultural fields) and arsenic concentrations. Approximate acreages for the various facility areas are as follows: 6 acres are roadway right-of-ways, 1 acre represents residences and will be addressed under the Community Soils OU, 74 acres are borrow areas, 8 acres are facilities, 92 acres are historic, 23 acres are the moto-cross facility and 8 acres are junk yard. These facilities will be addressed to determine that performance standards, as appropriate, have been met. Future monitoring of these areas may be required to assess performance standards, if any. Polygon OWSR-004.02, approximately 8 acres, is designated as a Facility-Junk Yard and has surface arsenic concentrations above the human health action level of 500 mg/kg. This area will continue to be used as a junk yard therefore it will be tilled to a depth of 6 inches to reduce arsenic concentrations to below the human health action level then it will be capped with 6 inches of pit run gravel. **There are approximately 212 acres of Facilities within RDU 1.**

2.4.7.2.4 Rock Areas

Rock areas are primarily rock outcrops, but may also be areas which prohibit tillage due to high surface rock content. These areas are generally erosionally stable. These areas will be monitored throughout implementation of remedial actions in adjacent areas and during post-remedial action monitoring of remediated areas as outlined in the VMP. Detailed methods and procedures for vegetation monitoring activities are identified in the Vegetation Management Plan. **There are approximately 48 acres of Rock Areas in RDU 1.**

2.4.7.2.5 PR (Previously Reclaimed).

These areas do not require implementation of a remedial action as previous reclamation, land management or development activities have been implemented. In most instances, these areas were remediated according to agency approved Design Reports/Remedial Action Work Plans. In some areas land management or development activities implemented by landowners within ARWW&S OU have resulted in areas meeting performance standards. PR areas will be addressed as appropriate under the Final Monitoring and Maintenance Plan (Atlantic Richfield, 2005c, In Progress. **There are approximately 312 acres of PR areas in RDU 1.**

2.4.8 Design Logic/Alternative Evaluation

As previously stated, evaluation of remedial requirements within an impacted area and selection of an appropriate remedial alternative is based on slope steepness, existing vegetation cover, soil pH and COC concentrations within a polygon. Slopes steeper than 3H:1V provide safety concerns and implementability issues including equipment accessibility. Slopes 2H:1V or

steeper will not be accessed by equipment. The remedy chosen for these areas with slopes steeper than 3H:1V is SSR.

Non SSR areas with higher vegetation cover greater than 30% (LRES – 115) generally result in selection of a less intensive remedial action. A polygon with a LRES score greater than 115 is designated as a "Well Vegetated" remedy as these areas currently achieve performance standards. In areas where the action levels are exceeded (arsenic concentrations greater than 1,000 mg/kg) and/or the vegetative cover is less than 30% (LRES < 115) the area will be tilled as necessary with soil amendments to meet the applicable human health arsenic action level and provide a suitable growth medium. In areas where the 500 mg/kg action level for commercial/industrial properties is appropriate, the area may be tilled, as necessary or engineered controls may be appropriate to meet the applicable human health arsenic action level.

Remedial action on steep slopes was determined during LRES Phase II. Since tillage cannot be implemented on steep slopes, due to safety concerns, the remedy consists of establishing vegetation by hand planting trees, shrubs and seeding grasses (PTSG). Erosion control will be accomplished by a combination of stormwater BMPs and/or engineered controls. The remedial alternatives that are evaluated are discussed in Section 2.4.7 and include remedy types SSR 1, SSR 2, SSR 3 and SSR 4. Determination of the steep slope remedial alternative is based on the steepness of slope, length of slope, existing vegetation, degree of erosion, and ICs, if appropriate. All alternatives include PTSG. The difference between SSR 1 through SSR 4 is the intensity of stormwater controls (i.e. BMPs) as described in Section 2.4.7.1.6. Based on field investigations, the intensity of stormwater BMPs and/or the need for engineered controls were determined. The stormwater BMP designs are presented in Appendix B.2 and the engineered control designs are presented in Appendix B.3. If a steep slope area (SSR-1, SSR-1/SSR-2, SSR-2, SSR-2/SSR-3, and SSR-3 polygons only) has a tillage polygon immediately upgradient of it, a Transition Zone of indeterminate width has been identified. Based on equipment access and safety this transition area will receive either tillage or dozer basins and/or regrading for control of surface water drainage and erosion. (See further discussion in Section 2.4.7.1.7.)

In RDU 1, remedial action will be implemented within impacted areas that are relatively flat tillable areas (areas with slopes less than 3:1) and steep slopes (areas with slopes steeper than 3:1). If a tillable area within RDU 1 requires treatment based on arsenic concentrations and/or LRES score/vegetation cover, the magnitude of the arsenic as well as the other COC concentrations and the need for soil amendments were evaluated to determine whether tilling could achieve the open space human health action levels for arsenic (1,000 mg/kg or 500 mg/kg, where appropriate) and provide a suitable growth medium. If arsenic is greater than 1,000 mg/kg, or 500 mg/kg, where appropriate, within a given non SSR polygon, a tillage remedy is used to reduce arsenic to below this action level. If it is determined that tillage could not reduce arsenic concentrations below actions levels, then stripping of highly impacted soils, cover soil or a combination of alternatives were evaluated. However, if tillage could reduce arsenic concentrations, soil amendment requirements are then evaluated in the 0-6" and 6-12" soil layers. If soil pH is above 6.5 s.u. in the 0-6" and 6.0 s.u. in the 6-12" soil layers, tillage (T6 or T12) with lime addition is not required and tillage is only necessary to achieve reduction to less than 1,000 mg/kg arsenic or 500 mg/kg, where appropriate. If soil pH is less than 6.5 s.u. in the 0-6" and 6.0 s.u. in the 6-12" soil layers, tillage (T6 or T12) with the addition of lime is required to achieve reduction to less than 1,000 mg/kg and to provide a suitable growth medium. The lime rate for polygon OWSR-004.04 includes a 25% safety factor because the area exhibits

potential acidity thus requiring residence lime to counter re-acidification of the soil profile (see Tables A-1 and A-3).

If the LRES score is less than 115 and/or arsenic concentrations are less than 1,000 mg/kg, tilling (T6 or T12) with or without amendment may be required to attain conditions suitable for plant growth. If the land use within an area is commercial/industrial (500 mg/kg action level), tilling or engineered covers, as required, may be appropriate in meeting the action level.

The design for non steep slope areas is based on using a preponderance or majority of the data considered to be representative of the site conditions for a given sub polygon (i.e. 3 out of 4 data points) rather than the worst case data (i.e. single point arsenic concentration or pH value). Therefore, if the arsenic concentrations are below the human health action level and LRES is greater than 115, then remedial action is not required to address human health or plant growth requirements and the areas is designated as Well Vegetated. If an open space/recreational area exhibits close to 30% cover and arsenic less than 1,000 mg/kg (human health action level) then the area is designated as Monitor-Well Vegetated and will be monitored under the Vegetation Management Plan. Monitor-Well Vegetated areas often require weed spraying and monitoring to verify attainment of 30% cover. However, if a preponderance of the data indicate elevated arsenic concentrations and vegetation cover is less than 30 percent (i.e., LRES <115) then tillage and amendment may be necessary to reduce arsenic concentrations to less than the applicable arsenic action level and/or attain a suitable growth medium.

The evaluation for the revegetation of non SSR areas in RDU 1 did not consider placement of coversoil or large scale removal as action levels and vegetation standards can be attained through less intense remedial actions (i.e., tillage). Tillage to 18-inches is not required or considered a desirable remedy as impacts have been demonstrated, based on data, to be located primarily within the upper 12 inches of the soil profile and action levels and establishment of a suitable growth medium can be achieved through shallower tillage (i.e., LT, T6 or T12). Additionally, historic projects have demonstrated that resulting soil profiles often become rockier and a less desirable plant growth medium is created as a result of deeper tilling.

Sheet 7 provides the remedies chosen for all polygons. The Design Criteria Summary Tables (included in Table A-1 of this FDR) summarize data used, assumptions made and remedy types selected per subpolygon.

During LRES Phase III, sampling was performed on a grid and sample locations within a PRLU were chosen in areas most representative of the soils within the given PRLU. Subsequently PRLUs were subdivided into subpolygons based on vegetation, landform and other features. This resulted in some areas not having data within the subpolygon. In some instances a data gap was identified and additional sampling performed. The data points and sampling results for each data point are listed on the Design Criteria Summary (DCS) for each subpolygon. If there is not a data point with a polygon then data is borrowed from adjacent or representative polygons. These areas are generally less than 5 acres in size. The distance to and landscape setting of adjacent polygons was a consideration to try and utilize the representative data. Polygons that share data will have the same remedy but may have different requirements such as preserving vegetation or rock outcrops therefore creating the need for division into separate polygons.

2.4.8.1 Evaluation of COC Concentration

In tillage areas, the predicted post remedy arsenic value for the tilled interval is calculated and shown on the individual DCS sheets, in Table A-5 and also on Sheet 2 of the FDR. The estimated post tillage arsenic value is determined by a weighted average of the pre-tillage As levels across the tilled depth for each data point. For example in a T6 area with As=310 (0-2") and As=580 (2-10") the predicted post remedy arsenic value would be 490 mg/kg. (e.g. 310*2/6 + 540*4/6). A tabular summary of estimated post-tillage As concentration is provided in Table A-5. If there is only pre-tillage As data in the 0-2" depth then the predicted post remedy As value is shown as less than the 0-2" value. In areas with high predicted post tillage arsenic, additional Phosphorous fertilizer may be added during tillage to enhance vegetation establishment.

2.4.8.2 Lime Requirements

In areas requiring tillage based on LRES score/vegetative cover and/or soil arsenic concentrations, the need for lime amendment, if any, is based on soil pH. EPA requires the highest lime rate for a polygon be used as the design lime rate. This rate is used since an average lime rate could potentially leave half of the polygon underlimed. Since the 25% safety factor is not used in the uplands lime rate determination (where potential acidity is not an issue) the chance for potential overliming is considered to be minimal. The 25% safety factor is used where acid producing materials have been identified as these materials exhibit potential acidity. ABA data indicate soil acidity as a function of both active and potential acidity. One polygon within the Stucky Ridge RDU (OWSR-004.04) exhibits potential acidity thus requiring residence lime to counter re-acidification of the soil profile. The lime rates in this area includes a 25% safety factor as noted in Tables A-1 and A-3. The data summary table found on Sheet 7 gives the uncorrected lime rate and minimum percent rock content. The lime rate is the maximum lime rate calculated for a polygon and is determined using the following formula:

- Lime Rate (tons CaCO3/1000 tons waste) = [(%HNO3-S+%Residual-S)31.25 + (%HCl)23.44 + SMP single buffer]1.0 (A 1.25 factor is used in areas with high potential acidity.)

If data is only available for the 0-6 inch interval and the remedy is a T12, the maximum lime rate is determined by multiplying the 0-6 inch lime rate by 1.66. In Light Till areas the 0-6 inch lime rate will be used. The uncorrected lime rate will be adjusted for lime quality and rock content during Remedial Action. Lime rates for tillage polygons requiring lime are summarized in Table A-3.

2.4.8.3 Rock Content Evaluation

The minimum rock content (averaged for depth) for a polygon as determined by screening soil samples through a 2mm sieve, is used to correct the field lime application rate and is determined using the following formula:

- (1 – (% rock content / 100)) but not to exceed 50 % soil rock content

The minimum rock content from the 0-6" interval is used for LT and T6 remedies and the minimum average of the 0-6", 6-12" and 12-18" (in fluvial areas) intervals is used for T12 and T18. If 6-12" data is not available for T12 areas, the 0-6" rock content will be used. In high rock areas (i.e. greater than 45-50% rock) tillage depths are evaluated on a case by case basis to avoid creating rock soil surfaces. Rock contents are summarized in Table A-4.

2.4.8.4 Fertilizer Requirements

A standard fertilization rate will be used for all of the areas addressed by this FDR consisting of 12-16-30 (%nitrogen, % phosphate and % potassium) fertilizer as identified in the Technical Specifications provided in Appendix B of the RAWPs. Additional Phosphorous may be considered in areas with high predicted post tillage arsenic and will be added at a rate of 200 lbs per 6 inch acre. These areas are identified on Sheet 7 and high phosphorus addition is noted on the DCS for each respective polygon.

2.4.8.5 Organic Matter Requirements

The use and need for organic matter amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis. Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. OM will not be utilized in areas where a defined A-horizon is identified. In areas where OM is determined to be required based on absence of an A-horizon, OM will be incorporated into the 0-6 inch interval. OM amendment shall have a 1 inch maximum particle size. Any particles larger than 1 inch will not be considered in the determination of OM content. The following criteria will be used to determine when the use of OM is appropriate:

- Throughout the soil profile where elevated metals (arsenic greater than 1,000 mg/kg) are present following mixing and reduction, or
- Where a continuous A-horizon can not be identified (A visually identifiable soil A-horizon is defined as being in the range of four to six inches with the soil exhibiting a dark soil color consistent with conventions of soil taxonomy.

1. The amount of OM amendment required for a given polygon will be determined prior to remedial action. The OM content of the soils will be determined by observation of a series of hand dug pits (one per 10 acres) in tillage areas by Agency and Atlantic Richfield representatives prior to implementation of the remedy. If a continuous A-horizon cannot be identified, the following approach shall be utilized to determine OM content: For areas receiving LT, T6 and T12 remediation, one composite sample consisting of at least 5 sub-samples for the 10 acre grid will be collected prior to remedial action from the interval to be tilled (i.e. 1 to 6 inch interval for LT and T6 and 0 to 12 inch interval for T12) and analyzed for organic matter using the Walkley Black procedure.

   Based on analyses, the OM content of the upper six inches of the soil profile within tillage areas, where OM is required, will be adjusted to achieve 1.5 percent OM in the top six inches based on dry weight or 3% throughout the soil profile in the case that the soil arsenic concentration cannot be reduced via tilling to below 1,000 mg/kg.

2. For areas receiving T18, organic matter amendment shall be added at a rate of 1.5% (dry weight) to the 0-6 inch profile.

If required, OM amendment will be incorporated following lime application (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment) prior to seeding. Application of OM will be performed in accordance with Specification Section 02970 – Organic Amendment and Mulching and CQAP Section 02970 – Organic Amendment. The use of OM within RDU 1 will be determined prior to construction based on field inspections to verify the presence of the soil A-horizon.

2.4.8.6 Seeding Requirements

A primary seed mix has been developed for tillage areas within Stucky Ridge Areas No. 1 through 4 based on site-specific hydrologic regimes, soil texture, slope and aspect. This mix is Revegetation Mix 1. A cover crop will be planted in tillage areas seeded with Revegetation Mix 1 to provide interim protection during the establishment year, to help control wind and water soil erosion on disturbed areas, and to combat establishment of weeds. Since cover crops compete for water, light, and nutrients, they must be compatible with the seedling forage. Areas receiving Revegetation Seed Mix 1 will be seeded with an annual cover crop of barley or other suitable species (annual rye). The cover crop will be incorporated into the upland seed mix at a rate of 10 pounds PLS/acre.

Revegetation Mix 6 is for use in SSR areas and will be broadcast seeded using a mix consisting of Great Basin wildrye, western wheatgrass, bluebunch wheatgrass, big bluegrass and sheep fescue.

All seed mixes include species that have been demonstrated to be successful at other areas of the Smelter Hill NPL Site and include a mixture of rhizomatous and bunch grass species that will aid in reducing soil erosion. Seeding methods and procedures are presented in Specification 02940-Seeding. Polygons and the associated seed mix to be implemented within each RAWP area are shown separately on Sheet 7. Acknowledgment of individual landowner seed mix requests will be addressed in a Request for Change (RFC). See CQAP Section 01100 (Appendix C of the RAWP) for a RFC form.

2.4.8.7 Other Evaluations

Remedial activities are not anticipated within wetland areas – wetland areas will be avoided. Though no formal assessment of wetlands has been completed for the RDU-3 Area, wetlands will be delineated prior to remedy implementation. If wetlands are identified within RA areas they will be mitigated as art of the 4-step UCFR Wetland Mitigation Process as follows:

Step 4, Confirmation of Response Action Impacts, is conducted following completion of the remedial actions to confirm that the detailed design was performed as specified. Step 4 is not intended to quantify FEWA for mature post-remedial wetlands, which require sufficient time to develop wetland soils and plant communities (generally expected to be 10 years or more). In this step, final wetland acreages are totaled, modification of the response action design described, and post-response functional assessments conducted. Comparisons are made of pre- and post-response action functional assessments and functionally effective wetland areas in order to evaluate the success of the project in meeting the "no net loss" of wetlands goal for CFR Superfund sites.

Limited clearing and grubbing of vegetation debris will be performed within the area addressed by this FDR and will consist of only that necessary for access roads, staging/amendment storage

areas or clearing of dead debris to allow for implementation of the remedial action. To the extent possible, live vegetation will be preserved during construction related activities.

Site grading will be conducted, as necessary, for construction of staging areas to protect against surface water run-on/run-off. Grading will also be performed prior to tillage and steep slope activities in areas where existing erosion rills/gullies are sufficiently deep and pervasive that they serve as a limitation to amendment application and do not allow for effective and efficient tillage of the soil. Deep primary drainages will not be graded. To the extent possible, grading activities will be performed during clearing and grubbing of vegetation debris and shall work within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation.

Placement of construction BMPs shall be completed in areas of concentrated flow that could impact ephemeral drainages and ditches within the work areas. BMPs will be implemented when construction operations are in progress in and around natural drainages. During site work activities, standard BMPs will be followed to divert storm water around the work area and minimize storm water runoff from transporting sediments downgradient, to the extent practicable. These measures may include upgradient berms, straw bale check dams, temporary ditches and/or silt fence. See the Uplands CQAP (Appendix C of the RAWP), and the Construction Storm Water Erosion Control Plan (Appendix B of this FDR) for additional details.

Areas of existing trees and vegetation will be maintained during implementation of the RAs, to the extent possible. As necessary, improvement or enhancement of these areas will be performed. The species present within these areas have been used as guidance for development of the design. Emphasis shall be placed on saving mature vegetation given the time required to grow to maturity and on preservation of native grasses and forbs. Forbs, in particular are difficult to establish from seed. Tilling activities will be implemented within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation. To the extent that safety is not compromised and existing desirable vegetation is not impacted, tillage areas will overlap into adjacent polygons of good vegetation.

Land ownership is also evaluated. Property that may be developed may receive more intense reclamation if arsenic concentration can be reduced to less than the residential action level (250 mg/kg).

The arsenic action levels utilized in the design logic above are based on the human health action levels developed for recreation/open space which is 1,000 mg/kg and for commercial/industrial which is 500 mg/kg.

2.4.9 Design Examples

The following discussion presents examples of how using the logic described in Section 2.4.8 leads to selection of a remedial alternative/identification of a remedial action for specific polygons.

OWSR-048.01 (in Stucky Ridge Area No. 1): The first step in the remedial action decision is the determination of the arsenic action level. OWSR-048.01 is considered open space/wildlife

habitat and therefore the action level is 1,000 mg/kg. The slopes in this polygon are less than 3H to 1V and therefore are not considered steep slopes.

The data shows that OWSR-048.01 has moderate COC concentrations in the 0-2 inch soil layer (305 – 336 mg/kg As, 902 mg/kg Cu, and 271 mg/kg Zn). These data indicate arsenic concentrations below the human health action level for open space, but above the residential action level. From reviewing the data associated with this polygon, it was determined that the arsenic does not exceed the action level for open space. However, assessments performed during LRES Phase II resulted in a site score of 60 for this area. Since LRES is less than 115 and the area is not a steep slope, treatment of this area will be implemented to reduce arsenic concentrations and/or to improve vegetation through incorporation of soil amendments. Soil amendment will be performed during tilling to improve vegetation as soil pH is less than 6.5 in the 0-6" interval and less than 6.0 in the 6-12' layer. In both of the sample points associated with this polygon, the soil pH is low at a depth of 12 inches (4.69 – 5.4), therefore the selected remedy is to till to 12 inches (T12) and incorporate lime amendment to provide a suitable growth medium.

Once a remedy is chosen there are several other factors that are evaluated to address site specific conditions. First is rock content. If the rock content exceeds 50% in any soil layer, tilling is not appropriate. OWSR-048.01 has moderate (21.7 – 25.6 percent) rock content in both the 0-6 and 6-12 inch soil layers, so tilling to 12 inches is appropriate. The lime rate will be adjusted (reduced) to account for rock content (See Table A-4 Rock Content Calculations). Other such considerations are proximity to wetland areas. A sufficient buffer area will be maintained around existing wetlands, in order to minimize potential adverse effects of encroachment around these sensitive areas. Another consideration is accessibility of equipment and amendments to a location. In most cases, mechanized equipment can access the remedial action areas; however, if some areas are not accessible to mechanized equipment, the monitoring remedy will be implemented. In most cases in the Upland remediation areas, mechanized equipment can access the remedial action areas, in areas where this is not the case, treatments implemented by hand will occur such as SSR. The southern boundary of OWSR-048.01 is a steep slope, so care will be taken to maintain the safety of the equipment operators at the time of remedial action.

Tilling will generally avoid areas of good vegetation as identified in the field and/or preconstruction site walkthrough.

In some areas the design logic presented above was supplemented with professional judgment to arrive at an appropriate remedy. One such area is subpolygon OWSR-041.04. Located in Stucky Ridge Area No. 1, this polygon has a land use of open space/recreational, was not scored during LRES Phase II and has a vegetation cover estimate of 10 percent. The arsenic and COC concentrations are well below the human health action levels, but the low vegetation cover coupled with the area being less than 3H:1V indicates that the area receive a tillage treatment. Lime amendment and incorporation during tillage will be implemented to improve plant establishment as soil pH levels are less than 6.0 s.u. in both the 0-6 and 6-12 inch soil layers so the recommendation would be till to 12 inches with the incorporation of lime. However, the rock content in the 6-12 inch soil layer is 79.3% which is greater than 50% thus limiting tillage to 6 inches. Based on the data, the vegetation condition and the rock content at depth, a remedy of T6 with lime addition was selected.

OWSR-013.03: This polygon is an example of a steep slope remedy. OWSR-013.03 faces the town of Anaconda and is located below a large tillage area (OWSR-013.09-A). The first step is to determine the human health action level. The arsenic concentrations range from 200 -624 mg/kg, which is below the human health open space action level. The vegetation cover in this polygon is estimated at 5 - 10% based on aerial interpretation, and as a result this polygon will not receive a WV or a M-WV designation. Due to the steepness of the slopes (>3H:1V) this polygon will receive a SSR type remedy. This subpolygon is a long steep slope area that can be accessed by tracked equipment. The remedy for this subpolygon is an SSR-2/SSR-3 remedy which will include dozer basins for on-slope BMPs, planting of trees and shrubs, and hand broadcast seeding with seed mix number 6 (see Technical Specification Section 02940 – Seeding). Since this polygon borders a flat tillage area, tilling will be extended to the safest extent possible following the topography, not strictly the map boundaries. This polygon also has upgradient tillage polygons (OWSR-030, OWSR-031.03, and OWSR-031.055) therefore it will include a Transition Zone, as shown on Sheet 7, which will be addressed according to Section 2.4.7.1.7.

For the examples provided above, in most cases the land reclamation technologies will be supplemented by storm water runoff controls/BMPs to reduce erosion and sediment transport. Storm water controls/BMPs have been designed for implementation where erosion is occurring and could potentially impact the reclamation and in areas where erosion has been determined to be a source of sediment loading to tributaries or streams (storm water controls include dozer basins, brush boxes, check dams and other BMPs). The storm water controls/BMPs selected for use in most Upland areas are discussed in Section 3 and Appendix B, shown on Sheet 6 and are detailed on Sheets 0.3, 0.4, 0.5, 0.6 and 0.7. Design calculations for these controls are presented in the Storm Water Runoff Control Plan for Best Management Practices (Appendix B.2). The Surface Water Technical Memorandum/Management Plans for the Lost Creek and Warm Springs Creek Drainages (Atlantic Richfield Company, 2002a, b, & c) and relevant DSRs present water quality analytical results for sampling stations along Lost Creek, Warm Springs Creek, and discuss compliance with water quality standards. Section 3.0 of this document provides a summary of this information.

2.5 Performance Standards/ARAR Analysis

- Site-wide ARARs set forth by EPA and MDEQ for RD/RA activities at the ARWW&S OU were identified in Appendix A of the September 1998 ROD and are restated as they apply to the RD in Section 7 of the RDWP. Final performance standards are identified in the Final Monitoring and Maintenance Plan, or attachments to the Final Monitoring and Maintenance Plan.

A general description of ARARs that are applicable to the Uplands and the associated means for compliance for each ARAR are provided in Table 1 of this FDR.

2.6 Monitoring and Maintenance

As part of the remedial action for the RDU 1 – Stucky Ridge revegetation design, a Site-wide Vegetation Management Plan (VMP) as an attachment to the Monitoring and Maintenance (M&M) Plan have been developed during the RD process to assess long-term effectiveness and permanence of RA activities. The VMP and M&M Plans outline specific procedures to be performed in subsequent years following implementation of the RA. The intensity and period of

monitoring activities is based on the remedial action implemented, frequency of maintenance activities and current land use. It is anticipated that primary M&M activities will include:

1. Monitoring of vegetation establishment to identify potential corrective actions or maintenance activities necessary to meet performance standards (two to five years).

2. Weed control in accordance with local laws and ordinances.

3. Monitoring of remediated areas for erosion.

Based on the findings of monitoring activities, corrective actions can be implemented, as necessary, to correct the monitoring deficiency to allow attainment of the performance standards for delisting. The Vegetation Management Plan provides additional detail regarding monitoring activities, schedules, diagnostic monitoring, and maintenance.

Vegetation monitoring will consist of qualitative inspections performed on a yearly basis to evaluate the general site conditions, uniformity of vegetation cover, and noxious weed numbers and to identify erosion problems. A qualitative surface water runoff inspection shall be completed on an annual basis for performance/functionality of BMPs. Monitoring activities are discussed in more detail in the final Vegetation Management Plan.

3.0 SURFACE WATER

Runoff from Stucky Ridge drains toward two perennial streams. Runoff from the south facing slopes of the ridge drains toward the Warm Springs Creek drainage, whereas runoff from the north slopes drains toward the Lost Creek drainage. However, runoff from Stucky Ridge upland areas above the Old Works Golf Course does not drain to Warm Springs Creek. This runoff is captured by sediment ponds constructed as part of the Old Works Golf Course RA. Numerous intermittent drainages are present within the Stucky Ridge boundary (see Sheet 6). Some of the drainages are sufficiently well-vegetated to resist erosion and are considered stable. Several drainages within Stucky Ridge require some stabilization. Storm water engineered controls for portions of the RDU are in place as they were constructed under the OW/EADA OU. The detailed evaluations for additional storm water engineered controls and BMPs to reduce erosion and sediment loads in drainages requiring stabilization that were evaluated as part of the RD for Stucky Ridge are summarized in Appendix B of this FDR.

3.1 Surface Water Remedial Action Objectives

The remedial action objectives identified in the ROD and Section 12.2 of the RDWP are to achieve the following:

- *Minimize source contamination to surface waters that would result in exceedances of State of Montana Water Quality Standards"; and*
- *Return surface water to its beneficial use by reducing loading sources of COCs.*

3.2 Surface Water Remedial Requirements

Specific remedial requirements for specific drainages are identified in Section 9.6.2 of the ROD. Specific remedial requirements for individual drainages (i.e. Lost Creek and Warm Springs

Creek) as identified in the RDWP, are presented in the Lost Creek and Warm Springs Creek Surface Water Management Plans for the specific drainage.

3.3 Surface Water Quality

3.3.1 Lost Creek

As presented in the ARWW&S OU *Final Surface Water Technical Memorandum*, base flow, high flow, and storm event sampling has been conducted on Lost Creek. Additional storm event samples were collected on July 16 and July 17, 2001. Mass loading analyses have been completed on these data. COCs for Lost Creek include arsenic, cadmium, copper, lead and zinc.

3.3.1.1 Base Flow Surface Water Quality Data/Water Quality Standards Evaluation

A detailed water quality standards evaluation for Lost Creek is presented in the ARWW&S OU *Final Surface Water Technical Memorandum*. Historic base flow water quality data include results of surface water sampling events conducted in 1992, 1993, and 1999. Total recoverable arsenic concentrations exceeded water quality standards at Stations LC-2, LC-3, and LC-5 (see Figure 1) on May 9,1993. Total recoverable arsenic concentrations ranged from 10 micrograms per Liter (µg/L) to 19.1 µg/L during this base flow monitoring event. Dissolved arsenic concentrations were nearly identical to total recoverable arsenic concentrations. No other water quality standard exceedances have been found in Lost Creek during base flow.

3.3.1.2 High Flow Surface Water Quality Data/Water Quality Standards Evaluation

Historic high flow water quality data include results of surface water sampling conducted in 1993. A minor arsenic water quality standard exceedance occurred at Station LC-3 on May 23, 1993. The total recoverable arsenic concentration was 18.1 µg/L. Total recoverable copper concentrations exceeded water quality standards at Station LC-2 on May 23, 1993. Total recoverable copper concentrations ranged from 2.5 to 15.8 µg/L during this high flow monitoring event. No other water quality standard exceedances have been found in Lost Creek during high flow. Dissolved COC concentrations were nearly identical to total recoverable COC concentrations during each 1993 high flow monitoring event.

3.3.1.3 2001 Storm Event Sampling

Under the *ARWW&S OU Final Warm Springs Creek and Lost Creek Storm Event Sampling and Analysis Plan (SAP)* (AERL, 2001a), storm event sampling was conducted July 16 and July 17, 2001. Sampling locations and results are shown in the *Final Lost Creek Surface Water Management Plan (SWMP)*(Atlantic Richfield, 2005d)[IN PROGRESS].

Based on precipitation data collected at the Deer Lodge, Montana, Weather Station, 0.52 inches and 0.49 inches of precipitation fell on July 16 and July 17, 2001, respectively. Although these storms produced the most amount of precipitation noted during July and August 2001, each storm produced less precipitation than the 1-year, 6-hour return event (0.5-year, 24-hour return event) (*Final Lost Creek Surface Water Management Plan [SWMP]* [IN PROGRESS]).

One arsenic and 1 lead water quality standard exceedance occurred during this event, both at Station LC-2. Copper water quality standard exceedances occurred at Stations LC-1B, LC-1C, and LC-2. During sampling on July 16 and 17, 2001, no surface water runoff was observed crossing the Lost Creek road and reaching Lost Creek between Stations LC-1C and LC-2. Therefore, the source of storm water entering Lost Creek between Stations LC-1C and LC-2 was determined to be from the north side of Lost Creek within the RDU 2 boundary. Laboratory water quality analytical results are presented in the *ARWW&S OU Draft Warm Springs Creek and Lost Creek Storm Event Sampling Data Summary Report (DSR)* (AERL, 2002). Additional Agency-collected 2001 storm event sampling results are presented in the Data Summary Report (DSR), *Surface Water Sampling During Storm Events, June 4, 2001 and July 16, 2001 Sampling Events* (CDM, 2001).

One opportunistic storm water runoff sample was taken at Station LCT-4, which is between the east end of Stucky Ridge and Lost Creek Highway. This sample had water quality exceedances for total Arsenic, Copper and Lead and dissolved Arsenic and Copper. This data highlights the need for engineered controls for this portion of the drainage.

3.3.1.4 Mass Loading Analyses

Mass loading analyses were conducted using sampling data collected in 1993 and are presented in the ARWW&S OU *Final Surface Water Technical Memorandum.* Results indicated the largest loading of total recoverable arsenic occurs between Stations LC-3 and LC-4. This section of Lost Creek is a gaining reach indicating ground water inflow as the cause of arsenic loading.

3.3.1.5 Storm Event Analysis

In addition, a concentration loading analysis was completed on the July 17, 2001 storm event data, since flows at each sample station were not collected (due to the short storm event duration). In the concentration loading analysis, all flows were assumed to be equivalent and the relative increase in concentrations were assumed to represent loading increases. Nearly all storm event loading enters Lost Creek between Stations LC-1C and LC-2 (*Final Lost Creek Surface Water Management Plan [SWMP]* [IN PROGRESS]).

Data indicate that drainages on Stucky Ridge that drain toward Lost Creek may affect water quality in Lost Creek. Therefore, BMPs and/or engineered controls will be required for the protection of surface water quality in Lost Creek as well as protection of the Upland remedies.

3.3.2 Warm Springs Creek

Warm Springs Creek has been classified as calcium-carbonate type water with generally low suspended solids. The pH of the water is neutral to slightly alkaline and specific conductance is low, but tends to increase in the downstream direction. Constituents of concern in Warm Springs Creek include arsenic, cadmium, copper, lead, and zinc. The Warm Springs Creek hydrology has been derived primarily from synoptic monitoring events conducted in 1992 and 1993. Continuous flow monitoring was performed at stations WS-2, T-2, WS-3, WS-3A, WS-5, and WS-6 (see Figure 2) from 1991 to 1993 during the *ARWW&S OU Remedial Investigation (RI)*. In addition, the United States Geologic Survey (USGS) Station 12323770 has collected continuous flow measurements from 1984 to the present. Daily mean flows for the lower reaches from 1984 to 1999 ranged from 0 cubic feet per second (cfs) in August 1988 to 475 cfs

in June 1997. In the upper reaches, daily mean flows for 1991 through 1993 ranged from 15 cfs in February 1993 to 383 cfs in June 1991. Warm Springs Creek is diverted to the Gardner Ditch and the Montana Department of Fish, Wildlife, and Parks (MDFWP) diversion, which average flows measured approximately 45 cfs and 5 cfs, respectively.

Four synoptic surveys were completed in 1992 and 1993 during varying seasonal conditions to evaluate changes in stream gain or loss. Results of the synoptic surveys indicate that the reach between Stations WS-1 and WS-3 (in the vicinity of Anaconda and Old Works) is characterized as a transitional or constant reach, between WS-3 and WS-5 is identified as a losing reach, and between WS-5 to WS-6 is a transitional or constant reach. Details of the synoptic flow data are provided in the *ARWW&S OU Final Surface Water Technical Memorandum*.

3.3.2.1 Base Flow Surface Water Quality Data/Water Quality Standards Evaluation

A detailed water quality standards evaluation for Warm Springs Creek is presented in the *ARWW&S OU Final Surface Water Technical Memorandum*. Historic base flow water quality data include results of surface water sampling events conducted in 1985, 1986, 1990, 1992, 1993, and 1999. During the base flow events, total recoverable copper concentrations have exceeded water quality standards at Stations WS-1, WS-2, WS-3, and WS-4 with concentrations ranging from 16 micrograms per Liter (µg/L) to 51 µg/L. Total recoverable lead concentrations exceeded water quality standards at Station WS-3, during the high flow sampling event in June 1999, with a concentration of 6 µg/L.

Although the total number of water quality standard exceedances for copper and lead was minimal, the general trend indicates that concentrations increase from the upstream monitoring stations to the downstream monitoring stations. This trend also applies to the other COCs despite overall low concentrations.

3.3.2.2 High Flow Surface Water Quality Data/Water Quality Standards Evaluation

Historic high flow water quality data include results of surface water sampling conducted in 1989, 1991, 1993, and 1999. One total recoverable arsenic concentration exceeded water quality standards at Station WS-5 with a concentration of 22.7 µg/L. During the high flow events, total recoverable copper concentrations have exceeded water quality standards at Stations WS-2, WS-3, WS-4, WS-5, and WS-6 with concentrations ranging from 16.1 to 86.5 µg/L. Total recoverable lead concentrations have exceeded water quality standards at stations WS-2, WS-3, and WS-6 with concentrations ranging from 3.2 to 6.8 µg/L.

Although the total number of water quality standard exceedances for copper and lead was minimal, the general trend indicates that concentrations increase from the upstream monitoring stations to the downstream monitoring stations. This trend also applies to the other COCs despite overall low concentrations.

3.3.2.3 Storm Event Sampling

Seven storm events, consisting of snowmelt events and rain events, were sampled at Stations WS-1 through WS-6 between 1985 and 2001. Rain event sampling occurred on April 17, 1985, June 9, 1992, June 14, 1992, June 16, 1992, October 7, 1993, and July 16, 2001. Data from the October 7, 1993 rain event is not available. Only one snowmelt, on March 31, 1993, was sampled.

Under the *ARWW&S OU Final Warm Springs Creek and Lost Creek Storm Event Sampling and Analysis Plan (SAP),* Warm Springs Creek storm event sampling was conducted July 16, 2001. Sampling locations and results are shown in the *Final Warm Springs Creek Surface Water Management Plan (SWMP)* (Atlantic Richfield, 2005e)[IN PROGRESS].

3.3.2.4 Mass Loading Analyses

Mass loading analyses were conducted on 1999 data to further characterize Warm Springs Creek by identifying the source(s) of COCs entering the creek. The overall purpose of the mass loading analyses was to compare loading between pre- and post-OW/EADA RA. Because the most water quality standard exceedances occurred with copper, mass loading analyses were conducted for copper using water quality data from August 1992 (low), April 1993 (low), March 1999 (low), and June 1999 (high) sampling events. The mass loading analyses are presented in the *ARWW&S Final Surface Water Technical Memorandum*.

Sampling conducted in 1992, was limited to Stations WS-2, WS-3, WS-5, and WS-6. Results indicate that more than half of the copper loading occurred upstream of WS-2. Sampling conducted in 1993 included all monitoring stations with the results indicating that over 60% of the copper loading occurred at or upstream of WS-1. Loading analyses performed on March 1999 water quality data, indicated that most copper loading (dissolved fraction) occurred upstream of Station WS-2 then generally decreased downstream of Station WS-2. Copper loading was greatest at Station WS-6, although 95% of the loading calculated at WS-6 entered Warm Springs Creek upstream of Station WS-2. Other trends included a loading increase of 52% between Station WS-5 and WS-6 and a general decrease in copper loading between Station WS-2 and WS-5.

3.3.2.5 Storm Event Analyses

Historic storm event data indicate that the only water quality standard exceedances occurred at Station WS-3 on June 14, 1992 and June 16, 1992 for lead. For the snowmelt event, no water quality standards were exceeded. During recent storm event sampling performed in July 2001, water quality standards were exceeded for arsenic, copper, and lead for both stations sampled (WS-1A and WS-3). For the snowmelt event, no water quality standards were exceeded. For rain events occurring before 2001, the only exceedance (lead) occurred at Station WS-3 on June 14, 1992 and June 16, 1992. The lead water quality standard was exceeded with concentrations of 7 µg/L and 9.2 µg/L respectively

Existing storm water engineered controls for portions of Stucky Ridge were constructed under the Old Works/East Anaconda Development Area (OW/EADA) OU (ARCO, 1994b) Remedial

Action. Vegetation, consisting of native and turf grasses, was planted to minimize erosion on Stucky Ridge, the Old Works golf course, East Anaconda Yards, Red Sands, throughout most drainage ditches and along portions of Warm Springs Creek. Ditches and culverts were installed to provide diversion of surface flows into the eight sedimentation ponds constructed along Stucky Ridge and east of the Old Works golf course. Earthen dikes along Warm Springs Creek were protected from erosion using a combination of engineered improvements, existing channel riprap and vegetation. Additionally, BMPs have been incorporated into the Uplands Revegetation Design for RDU 1 to reduce the potential for impacts to Warm Springs Creek.

3.4 Remedial Design Alternatives

Remedial Action Objectives (RAOs) for surface water were established in the Anaconda Smelter NPL Site, Anaconda Regional Water, Waste and Soils Operable Unit Record of Decision (ROD) and the RDWP. The RAOs will be achieved through establishment of a permanent vegetative cover and through application of storm water engineered controls and/or surface water BMPs where appropriate. Final performance standards are identified in the final SWMP for each drainage. Revegetation to establish a self-sustaining assemblage of plant species will stabilize the soils against erosion and reduce transport of COCs to surface and ground water, maximize water usage thus reducing surface water run-off, re-establish wildlife habitat, and accelerate successional processes. Engineered controls such as sediment ponds and channels/ditches will be utilized, where necessary, to control sediment transport to downstream surface water receptors. Surface water BMPs such as check dams, grade controls, dozer basins, etc. will be implemented to control gully erosion and sediment transport until vegetation is established. Temporary construction BMPs that may be implemented to control erosion during construction and as general "housekeeping" measures include silt fence and straw bales, etc. and are described in Appendix B.1 of this FDR and Appendix D of the Stucky Ridge RAWPs.

Establishment of the permanent vegetation will be the most effective and permanent sediment and erosion control measure implemented at the site. A permanent self-sustaining vegetative cover will reduce surface water erosion and the associated COC transport to surface water.

Tilling and/or lime addition, as necessary, associated with establishing vegetation will reduce the concentration and/or mobilization of COCs in surface soils. The reduced concentration of COCs in the surface soils/sediment will reduce transport of COCs to surface water. Lime addition would also reduce the mobility of some COCs by increasing the pH of soils and thus the solubility of the metals present in the soil matrix.

Gully erosion is present in some areas throughout the site and is a source of sediment to surface water and down-gradient depositional areas. Gully erosion will be minimized by installation of surface water BMPs including check dams and grade controls, and in some cases, grading. Check dams will be installed in some drainages to provide sediment capture zones and to provide hard grade controls. Grade controls will be installed in some smaller drainages to minimize potential for down-cutting during high flows.

Erosion in steep slope areas (steeper than 3H:1V) will typically be minimized through installation of on-slope surface water BMPs, including dozer basins, brush boxes, etc. combined with the planting of trees and shrubs. Exact locations and applicability of each treatment is

highly site-specific: general locations of treatments are shown on Sheet 6. The actual areas and quantities to be installed will be determined in the field during construction based on site-specific conditions.

Sediment transport control will be accomplished by using the existing sediment pond system present at the Old Works Golf Course and through the use of new channels and ponds to be constructed at the east end of Stucky Ridge and the northeast corner of the site near the motocross track. Locations of the storm water engineered controls are shown on Sheet 6.

3.4.1 Temporary Construction Best Management Practices

Temporary erosion control practices to be employed during construction are further described in the Construction Storm Water Erosion Control Plan SWECP, (see Appendix B.1 of this FDR and D of the RDU 1 RAWP). These controls will generally include straw bales, silt fence, temporary diversions, and good housekeeping practices. These procedures are consistent with the State of Montana Sediment and Erosion Control Manual (DEQ, 1996).

3.4.2 Storm Water Best Management Practices

Sediment and erosion control will be achieved primarily through revegetation efforts and the application of long term Storm Water BMPs as described in the Storm Water Runoff Control Plan (SWRCP), see Appendix B.2. The primary goal of the storm water BMP design effort in the Uplands RA is to develop methods to stabilize the erosion prone slopes and ephemeral intermittent tributaries or drainages to Lost Creek and Warm Springs Creek as necessary in order to reduce potential COC and sediment loads in storm water runoff during vegetation establishment. The design elements are intended to reduce erosion of hillsides and drainages in order to protect the uplands remedies and reduce long-term Monitoring and Maintenance (M&M) requirements. These actions will subsequently reduce potential COC and sediment loads in the perennial streams.

The SWRCP for BMPs has been developed to reduce erosion, promote permanent vegetation, and minimize COC runoff by employing one or more of the following BMPs, when appropriate:

1. Soil stabilization techniques such as slope grading, roughening, and serrating;
2. Grade control and check dams in tributary drainages:
3. Sediment barriers (i.e. check dams) and filters (i.e. brush boxes);
4. Minimal mulch/matting to provide temporary protection for establishment of vegetation in tributary drainages; and
5. Tilling and planting to re-establish or improve vegetation to reduce erosion.

These BMPs have been selected to serve as both short- and long-term sediment and erosion control measures, and to assist in natural recovery of the drainages. An assortment of BMPs (referred to herein as the "toolbox") was developed. The intent of the BMPs is to enable the designer/field oversight to select one or more BMPs from a multitude of BMPs for use in areas

of concern. The toolbox approach will enable similar design elements to be employed in each tributary, as required, and will result in increased design efficiency, construction efficiency and construction quality. Currently, the design tool box contains numerous types of BMPs that could be employed. Each BMP is applicable and most appropriate for a certain existing condition.

BMPs proposed for use at the site have been selected to address the varied and complex conditions present in the uplands areas. Many areas of the site have limited access. Erosion control measures may be limited to BMPs that can be installed using hand labor. Furthermore, it is considered prudent to install measures that will provide temporary sediment control during construction activities as well as provide long-term sediment/erosion control and enhance the stability of the drainages. Specifically, BMPs such as dozer basins, check dams (all types), log grade control structures, vegetative buffer strips, and brush boxes will function well in both the short- and long- term.

3.4.3 Storm Water Engineered Controls

The conceptual design for the Stucky Ridge Storm Water Engineered Controls was originally described in the *Final Conceptual Storm Water Runoff Control Plan for the ARWW&S OU*. Two sediment ponds will be constructed to intercept stormwater runoff from Stucky Ridge. One sediment pond (the North Sediment Pond) will be constructed near the northeast end of Stucky Ridge (See Sheet 6 for location and Appendix B.3 for the design). This pond will intercept all runoff in the existing storm water channel that conveys flows from the north side of Stucky Ridge. The existing storm water channel will be re-constructed from the pond location west for approximately 6,000 feet and additional channels will be improved or reconstructed at each of three drainages to convey flows into the new intercept channel. Discharge from the sediment pond will flow into the existing storm water ditch which drains into Gardiner Ditch.

Interceptor channels will be constructed along the east end of Stucky Ridge and immediately west of the Drag Strip (see Sheet 6 for location). These ditches will convey storm water runoff to a sediment pond constructed north of the Drag Strip, adjacent to Gardiner Ditch (the South Sediment Pond). Discharge from the south pond will flow into Gardiner Ditch. Detailed design for the engineered storm water controls is included in Appendix B.3 – Engineered Storm Water Control Plan.

3.5 Final Design

It is anticipated that implementing land reclamation technologies to address impacted soils and storm water BMPs to help reduce erosion and sediment transport within Stucky Ridge will help improve water quality within the Lost Creek and Warm Springs Creek watersheds. Storm water BMPs will be implemented where erosion is occurring and could potentially impact the reclamation and in areas where erosion has been determined to be a source of sediment loading to tributaries or streams (storm water BMPs include brush boxes, check dams and other BMPs).

The storm water BMPs selected for use on Stucky Ridge are shown on Sheet 6 and are detailed on Sheets 0.3, 0.4, 0.5, 0.6 and 0.7 in this FDR. Design calculations for these controls are presented in the SWRCP for BMPs for Stucky Ridge (Appendix B.2). Locations of BMPs shown on Sheet 6 are based on existing conditions. Implementation of the RA may change locations or quantities due to expansion of upgradient or adjacent remedies or through implementation of alternate approaches.

In addition to the surface water controls implemented as part of the OW/EADA OU Remedial Action and the storm water BMPs that will be implemented during the Uplands RA, additional engineered controls will be constructed in RDU 1 to control COC transport from storm water runoff. The locations of these engineered controls are shown on Sheet 6 and the design calculations are included in the Engineered Storm Water Controls Plan (Appendix B.3).

The Surface Water Technical Memorandum/Management Plans for the Lost Creek and Warm Springs Creek Drainages presents water quality analytical results for sampling stations along Lost Creek and Warm Springs Creek, and discusses compliance with water quality standards.

3.6 Design Analysis

Soil treatments within RDU 1 will be implemented as a remedy for surface soil COC concentrations above the action level for the intended land use, as well as periodic surface water contaminant levels that exceed those stated in WQB-7 for acute and chronic threats to human health and aquatic life. The RD is intended to comply with WQB-7 within the ARWW&S OU and will be monitored under the SWMP attachment to the Sitewide M&M Plan. Logic and design analysis regarding the inclusion or exclusion of specific measures for controlling surface water runoff and erosion can be found in the Construction Storm Water Erosion Control Plan (Appendix B.1), the Storm Water Runoff Control Plan for BMPs (Appendix. B.2) and the Engineered Storm Water Controls Plan (Appendix B.3). Final performance standards are identified in the Final M&M Plan.

3.7 Performance Standards/ARAR Analyses

Site-wide Applicable or Relevant and Appropriate Requirements (ARARs) set forth by EPA and MDEQ for RD/RA activities at the ARWW&S OU were identified in Appendix A of the September 1998 ROD and restated as they apply to the RD in Section 7 of the RDWP. Applicable ARARs will be met through the establishment of vegetation and BMPs. A general description of ARARs which are applicable to the RDU 1 and the associated means of compliance for each ARAR are provided in Table 1.

Applicable surface water standards include contaminant specific requirements are set forth in the: Federal Surface Water Quality Requirements, Clean Water Act, 33 U.S.C. §§ 1251, et seq.; State of Montana Surface Water Quality Requirements, Montana Quality Act, MCA § 75-5-101, et seq., and implementing regulations. Applicable surface water ARARs that include contaminant specific requirements will be met through the implementation and maintenance of storm water engineered controls/BMPs as well as the establishment of vegetation cover. BMP effectiveness will be monitored during and following RA (see Section 3.8 below).

Applicable surface water standards which include action specific requirements include: MCA § 75-5-605 and ARM § 17.24.633. MCA § 75-5-605 pertains to water requirements causing pollution. These standards will be met within RDU 1 by implementation and maintenance of storm water engineered controls/BMPs during and after the RA. ARM § 17.24.633 pertains to storm water runoff. These standards will be met through the implementation of storm water BMPs to control surface water impacts from storm water. During construction, erosion controls in disturbed areas will be used to control run on and run off (see Appendix B.1). Final performance standards are identified in the Final M&M Plan.

3.8 Monitoring and Maintenance

A qualitative erosion inspection shall be completed on a yearly basis for performance/ functionality of BMPs. Additional inspection tasks and/or inspections that are more frequent may be conducted to account for site specific factors, weather conditions, or unforeseen circumstances. A checklist format for BMP inspections is included in the Vegetation Management Plan, an appendix to the Site wide M&M Plan. The effectiveness of BMPs will be noted as will the need for additional BMPs or maintenance of existing ones. Surface water monitoring will be performed in accordance with the Surface Water Management Plan

Yearly qualitative inspections of surface water control structures will occur annually and after all significant storm or run-off events. Structures shall be inspected for obstructions, debris or silt accumulation, erosion, general conditions, and the condition of riprap or other erosion protection. A photographic record of major surface runoff and erosion control features shall be maintained to allow comparison for subtle changes over time that may indicate problems. A checklist format for these inspections is included in the Engineered Controls Maintenance Plan, an appendix of the Site wide M&M Plan.

4.0 GROUND WATER

In 1996, the EPA presented the *Ground Water Technical Impracticability Evaluation (TI) for the ARWW&S OU* (EPA, 1996). Results of this TI Evaluation revealed that arsenic concentrations exceeded the RA goals for arsenic (18 µg/L) in the bedrock ground water aquifer within portions of the Stucky Ridge TI Zone. The EPA granted a TI waiver of the arsenic performance standard in the ROD. Performance standards for cadmium, copper, lead, and zinc are effective in the TI Zone.

Thus, no active groundwater remedial action is required for the Stucky Ridge RDU. Therefore, this section describes the status of groundwater conditions at the RDU and the use of ICs as a remedial action for ensuring protectiveness of human health and the environment. As shown on Sheet 5, the Stucky Ridge TI Zone encompasses approximately 10 square miles and RDU 1 is located primarily within the Stucky Ridge TI zone boundary. Principle landowners within the Stucky Ridge TI Zone include ADLC, the State of Montana, and private landowners as shown on Sheet 3. The Stucky Ridge TI Zone was defined during ARWW&S OU Short-Term Ground Water Monitoring Data Analysis Report (DAR) (AERL, 2003). Historic sampling events involving alluvial wells have not been affected by the elevated arsenic concentrations in the Stucky Ridge bedrock system. Therefore, the bedrock-alluvium contact defines a portion of the TI Zone boundary.

The Long-Term Ground Water Monitoring Network for the Stucky Ridge TI zone will consist of alluvial aquifer PWs and POC monitoring wells, bedrock aquifer performance monitoring wells, and regulatorally complete domestic wells. The long-term Ground Water Management Plan (GWMP) attachment to the Site wide M&M Plan describes in detail the monitoring requirements for the Stucky Ridge TI Zone.

4.1 Remedial Design Alternatives

As stated in the ROD:

> *"EPA and MDEQ consider it to be technically impracticable to restore ground water quality in the bedrock aquifers to levels below the Montana Ground Water Quality Standard for arsenic, since: 1) the primary source of arsenic to ground water is infiltration of precipitation through widespread areas of contaminated soils; and 2) the contaminated zones are dispersed throughout fractured bedrock aquifer systems. As provided under Section 121(d)(4)(c) of CERCLA, the ground water standard for arsenic is waived within TI zones due to technical impracticability.*
>
> *The following remedial actions will be taken to minimize on-going transport of COCs to the bedrock aquifers, protect domestic water users, and provide for contingency water systems in the event of newly identified user:*
>
> *1. Complete source control measure through waste consolidation and implementation of in-situ revegetation or soil cover treatments.*
>
> *2. Implement ICs to monitor and regulate domestic ground water use.*
>
> *3. Establish a long-term monitoring plan.*
>
> *4. Complete site characterization to better define lateral and vertical extent of TI Zones.*
>
> *5. Provide for alternative water supplies."*

Item 1 is being addressed in the RDU 1 vegetation design described herein. Item 2 is being addressed in the ARWW&S OU Site-wide Institutional Controls Management Plan. Items 3 and 5 are being addressed in the Long-Term Ground Water Management Plan and Site wide M&M Plan. Item 4 has been addressed during short-term ground water monitoring, and TI Zone boundary delineation.

4.2 Final Design

The ARWW&S OU ROD requires that long-term ground water monitoring be implemented at Waste Management Areas (WMA), Areas of Concern (AOC), and Technical Impracticability (TI) Zones. As previously discussed, a TI waiver of the arsenic performance standard was granted for portions of Stucky Ridge in the ROD. Performance standards for cadmium, copper, lead, and zinc are effective in the TI Zone.

Principle landowners within the Stucky Ridge TI Zone include Atlantic Richfield Company, ADLC, the State of Montana, and private landowners. Future development and use of ground water within Stucky Ridge must be consistent with requirements set forth in the Final ICMP.

Sheet 5 contains the boundary of the TI Zone, domestic well locations and performance/ compliance monitoring network are identified in the Long Term Ground Water Management Plan (Atlantic Richfield, 2005f)[IN PROGRESS].

4.3 Design Analysis

The design for groundwater in RDU 1 is the development of ICs to monitor and regulate domestic ground water use. As outlined in the ROD, no active groundwater remediation will be implemented. Thus the details for the ground water ICs design are presented in the ICMP.

4.4 Performance Standards/ARAR Analyses

Sitewide Applicable or Relevant and Appropriate Requirements (ARARs) set forth by EPA and MDEQ for RD/RA activities at the ARWW&S OU were identified in Appendix A of the September 1998 ROD and restated as they apply to the RD in Section 7 of the RDWP. Contaminant specific groundwater standards include ARAR requirements set forth in Montana Requirements, MCA § 75-5-303, ARM § 17.20.1002, -1003, and -1011. However, it is not anticipated that remediation will result in any further degradation of groundwater quality within RDU 1.

A general description of ARARs which are applicable to RDU 1 and the associated means of compliance for each ARAR or standard are provided in Table 1. Final performance standards are identified in the Final M&M Plan.

4.5 Monitoring and Maintenance

Locations and schedules for monitoring activities are described in the long term GWMP attached to the Site wide M&M Plan. Monitoring activities will document the quality of the ground water plume and the long-term efficiency of RAs affecting ground water quality within the Stucky Ridge TI zone. Compliance monitoring will be conducted to ensure water quality standards are met at POC locations.

5.0 INSTITUTIONAL CONTROLS

5.1 Remedial Design Alternatives

The ARWW&S ROD specifies that an ICs program be developed in conjunction with the selected reclamation and engineering controls to include land use restrictions and zoning, ground water controls, and public notices or advisories. The details associated with each of these controls as well as others is defined in the Sitewide ICMP.

The ROD states

> "*ICs are a necessary supplement to reclamation and engineering controls when waste is left in place or ground water will continue to exceed standards… Therefore, EPA and MDEQ expect ICs to play an integral part in the Selected Remedy to assure future protection of human health and the environment. An ICs program will be developed in conjunction with the selected reclamation and engineering controls to include three basic components; land use restrictions and zoning; ground water controls, and public notices or advisories.*"

The Selected Remedy, through IC's will:

- *Assure that future land and water use at the site is consistent with EPA's determination of the health and environmental risks posed by contaminants left on site;*
- *Provide for the preservation and maintenance of Superfund remedial structures on the site, including but not limited to engineered caps, covers, storm water conveyances, waste repositories and reclaimed areas;*
- *Require that future development at the site employ construction practices that are consistent with the protection of public health and the environment, as determined by Superfund remedial actions and in accordance with the requirements set forth by the Anaconda-Deer Lodge County Development Permit System;*
- *If development occurs at the site, implement the remediation of soil arsenic contamination to levels appropriate for the intended use, as determined by Superfund remedial actions;*
- *Provide for implementation of other laws applicable to development, such as subdivision and floodplain requirements; and*
- *Provide information and notice to the public (users or potential users of land or ground water) of some existing or impending risk associated with their use of the site.*

5.2 Final Design

The non-SSR reclaimed lands within Stucky Ridge are suitable for most types of development. However, certain institutional controls and procedures must be followed to protect human health and the environment in areas exceeding the residential action levels.

The Uplands revegetation design is based on the current land use cleanup action level; in this instance, the agricultural/open space human health arsenic action level of 1,000 mg/kg and the commercial/industrial action level for arsenic (500 mg/kg). The commercial/industrial action level for arsenic (500 mg/kg) is applicable to the junk yard area (polygon OWSR-004.02). Residential areas and the corresponding human health action level (250 mg/kg) are addressed under the CSOU and through the Superfund Planning Area Overlay District (SPAOD) portion of the Anaconda-Deer Lodge County (ADLC) Development Permit System (DPS). Future development of this area will require sampling and development requirements under the Final ICMP.

Specifically, ICs are outlined in the final ICMP. Restrictive covenants regulate development and ground water use. In addition, there are restrictions to regarding development in wetland and steep slope areas and in utility easements.

The Old Works High Arsenic Area has been designated in a portion of the RDU where steep slopes, historic structures, and rocky areas prevent the implementation of treatment or cover soil actions to reduce the surficial soil arsenic concentration below the human health cleanup action level for recreational/open space/agricultural soils (1,000 mg/kg). The boundary of the Old Works High Arsenic Area is shown in the final ICMP. ICs applicable to the High Arsenic Area are restrictive covenants, establishment of a ground water control area, and measures to limit land use as detailed in the ICMP.

A detailed discussion of ICs currently in-place or planned for use as part of the RA for the ARWW&S OU is presented in the Final Institutional Controls Management Plan (Atlantic Richfield Company, 2005g, in progress).

5.3 Design Analysis

A portion of RDU 1 is privately owned and has the potential for residential development. Treatment areas within the Stucky Ridge area will be remediated to post-RA arsenic concentrations of less than 1,000 mg/kg and 500 mg/kg, where applicable (junk yard). Through remediation, some areas of Stucky Ridge (RDU 1) will be remediated to post-RA arsenic concentrations of less than 250 mg/kg (see Sheet 7). Remediation of arsenic concentrations to residential action levels eliminates much of the need for ICs. However, for privately owned land that does not achieve arsenic concentrations of less than 250 mg/kg, ICs (as described in the Institutional Control Management Plan) will be implemented using the SPAOD portion of the DPS or another appropriate legal mechanism.

Purpose of Institutional Controls. The institutional controls set forth in the ICMP, in conjunction with the monitoring and maintenance measures described in the M&M Plans and/or required in connection with property maintenance will assure the long-term effectiveness of the Remedies. The institutional controls set forth in the ICMP also assure that: (a) future land uses and land use practices at the Site are consistent with the remedial objectives upon which cleanup level decisions for the various OUs and RDUs have been based, (b) the Remedies are maintained, and (c) remediation is performed, if necessary, when property is developed or land use is changed. The institutional controls also will assure that the Remedy is not compromised by development or land use activities on the remediated property. The institutional controls also will educate and inform landowners, builders, developers and the community of the appropriate methods to accomplish changes in use and development of lands within the Site.

Review of Effectiveness of Institutional Controls. Institutional controls established for the Site, as described in this ICMP, will be reviewed by the EPA every five years to assess whether the Remedies remain protective of human health and the environment.

Implementation of ICMP. The ICMP will be coordinated, implemented and managed by Atlantic Richfield with the assistance of ADLC. Roles and responsibilities of each of the parties relative to the long-term management and maintenance of the Site and with respect to future development will be developed.

5.4 Performance Standards/ARAR Analyses

Site-wide Applicable or Relevant and Appropriate Requirements (ARARs) set forth by EPA and MDEQ for RD/RA activities at the ARWW&S OU were identified in Appendix A of the September 1998 ROD and restated as they apply to the RD in Section 7 of the RDWP.

A general description of ARARs and performance standards which are applicable to the properties addressed in this FDR and the associated means of compliance for each ARAR or standard is provided in Table 1 of this FDR. Final performance standards are identified in the Final M&M Plan.

5.5 Monitoring and Maintenance

As part of the remedial action for the RDU 1 – Stucky Ridge, a Sitewide Monitoring and Maintenance Plan has been developed to assess long-term effectiveness and permanence of RA activities. The M&M Plan outlines specific procedures to be performed in subsequent years following implementation of the RA. The intensity and period of monitoring activities will be based on the remedial action implemented, frequency of maintenance activities and current land use.

6.0 REFERENCES

ARCO. 1996. Anaconda Regional Water and Waste Operable Unit Final Remedial Investigation Report. Prepared by Environmental Science & Engineering, Inc. for ARCO. February 1996, Volumes I - IV.

ARCO. 1997. Remedial Investigation Report, Anaconda Regional Soils Operable Unit, Anaconda Smelter NPL Site. Prepared for ARCO by Titan Environmental Corporation. February 1997.

AERL. 1999a Conceptual Storm Water Runoff Control Plan for the Anaconda Regional Water, Waste & Soils Operable Unit. January 1999. Prepared by Pioneer Technical Services, Inc.

AERL 1999b. Anaconda Regional Water, Waste and Soils OU and Old Works/East Anaconda Development Area OU, Wetland and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area, Anaconda Smelter NPL Site, May 1999.

AERL. 2001a. Final Warm Springs Creek and Lost Creek Storm Event Sampling and Analysis Plan. June 26, 2001.

AERL. 2001c. ARWW&S OU Draft Final 2000 Short-Term Ground Water Monitoring Data Analysis Report (DAR). Prepared for AERL by Pioneer Technical Services.

AERL. 2002. Draft Warm Springs Creek and Lost Creek Storm Event Data Summary Report. (January 8, 2002).

Atlantic Richfield Company. 2002. Final Data Summary Report (DSR) for Land Reclamation Evaluation System (LRES) Phase III Sampling and Analysis Plan (SAP), Volumes I and II. Anaconda, MT.

Atlantic Richfield Company. 2002a. Final Surface Water Technical Memorandum. Prepared for ARCO by Pioneer Technical Services. March 27, 2002.

Atlantic Richfield Company. 2003. Draft 2002 Short-Term Ground Water Data Analysis Report (DAR). Prepared for the Atlantic Richfield Company by Pioneer Technical Services. February 21, 2003.

Atlantic Richfield Company. 2005a. Remedial Action Work Plan Stucky Ridge RDU 1 Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. Prepared for the Atlantic Richfield Company by Trec, Inc.

Atlantic Richfield Company. 2005b. Vegetation Management Plan, Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. Prepared for the Atlantic Richfield Company by Trec, Inc. [IN PROGRESS].

Atlantic Richfield Company. 2005c. Monitoring and Maintenance Plan, Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. [IN PROGRESS]

Atlantic Richfield Company. 2005d. Anaconda Regional Water, Waste & Soils OU, Final Lost Creek Surface Water Management Plan. [IN PROGRESS].

Atlantic Richfield Company. 2005e. Anaconda Regional Water, Waste & Soils OU, Final Warm Springs Creek Surface Water Management Plan. [IN PROGRESS].

Atlantic Richfield Company. 2005f. Anaconda Regional Water, Waste & Soils OU, Final Long-Term Ground Water Management Plan. [IN PROGRESS].

Atlantic Richfield Company. 2005g. Institutional Controls Management Plan, Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. [IN PROGRESS]

CDM. 1997. Final Baseline Ecological Risk Assessment, Anaconda Regional Water, Waste & Soils Operable Unit, Anaconda Smelter NPL Site, CDM-FPC, Golden, CO 80401.

CDM. 2001. Data Summary Report - Storm Event Sampling During Storm Events, June 4, 2001 and July 16, 2001; Anaconda Regional Water, Waste & Soils Operable Unit. September 27, 2001.

CDM and RRU. 1998. Best Management Practices for Upland Reclamation Activities within the Clark Fork River Basin. Reclamation Research Unit, Montana State Univ., Bozeman, MT.

CDM and RRU. 1999. Preliminary Draft LRES Phase II Report, Preliminary Land Reclamation Alternatives, Doc. No. 3280-001-OTHR-04850, EPA, Helena, MT.

EPA. 1996. Draft Feasibility Study Deliverable No. 3A, Ground Water Technical Impracticability Evaluation, Anaconda Regional Water, Waste & Soils Operable Unit. Prepared by CDM Federal for EPA. December 19, 1996.

EPA and MDEQ. 1998. Record of Decision, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. September 1998.

EPA. 2000a. 13th Amendment to CERCLA-VIII-88-16. July 2000.

EPA. 2000b. Final Remedial Design Work Plan, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. Prepared for EPA by CDM Federal Programs Corporation. June 26, 2000.

EPA. 2003. Agency Comments on RDU1 – Stucky Ridge Final Designs. January 2003.

Keammerer, W. R. 2002. Vegetation Establishment on Stucky Ridge Tilling Demonstration Plots. Prepared for ARCO by Keammerer Ecological Consultants, Inc. May 2002.

Montana Department of Environmental Quality. 1996. Montana Sediment and Erosion Control Manual. Prepared by Roxann Lincoln CPSS, MPDES Storm Water Program. Revised May 1996.

MDEQ and EPA. 2000. Data Summary Report, Delineation of Outer Boundary, ARWW&S OU, Anaconda Smelter NPL Site. Helena, MT.

Reclamation Research Unit. 1993. Anaconda Revegetation Treatability Studies. Phase I: Literature Review, Reclamation Assessments, and Demonstration Site Selection. Anaconda Smelter NPL Site. Reclamation Research Unit. Montana State University, Bozeman, MT 59717.

Reclamation Research Unit. 1996. Anaconda Revegetation Treatability Studies. Phase II: Final Report: Laboratory and Greenhouse Investigations. Doc. No. ASSS-ARTS-II-FR-F-070396. Montana State University, Bozeman, MT.

Reclamation Research Unit. 1997. Anaconda Revegetation Treatability Studies, Phase IV: Monitoring and Evaluation, ARTS Phase IV Final Report. Doc. No. ASSS-ARTS-IV-FR-073197. Montana State University, Bozeman, MT.

Tetra Tech 1987, Anaconda Smelter Remedial Investigation/Feasibility Study Master Investigation Draft Remedial Investigation Report. Prepared for Anaconda Minerals Company. March 1987.

ANACONDA SMELTER NPL SITE

ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT

Remedial Design Unit (RDU) 1 – Stucky Ridge Uplands Final Remedial Action Work Plan

Atlantic Richfield Company

Butte, Montana

June 2005

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LIST OF ACRONYMS and ABBREVIATIONS

ABA	Acid-Base Account
ADLC	Anaconda-Deer Lodge County
Agencies	EPA and MDEQ
AMC	Anaconda Mining Company
ARAR	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
ARTS	Anaconda Revegetation Treatability Study
ARWW&S	Anaconda Regional Water, Waste, and Soils
BERA	Baseline Ecological Risk Assessment
BMP	Best Management Practices
CCE	Calcium Carbonate Equivalence
CCR	Construction Completion Report
CDM	CDM Federal Programs Corporation
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CGWA	Controlled Ground Water Area
CPMP	Community Protective Measures Program
CQAP	Construction Quality Assurance Plan
CSK	Confederated Salish & Kootenai Tribes
DCR	Design Criteria Report
DNRC	Montana Department of Natural Resources and Conservation
DPS	Development Permit System
EPA	U.S. Environmental Protection Agency
FDR	Final Design Report
FRLU	Final Remedial Land Unit
GWMP	Ground Water Management Plan
IC	Institutional Controls
ICMP	Institutional Controls Management Plan
LRES	Land Reclamation Evaluation System
MDEQ	Montana Department of Environmental Quality
mg/kg	Milligrams per kilogram
mg/L	Milligram per liter
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
M&M	Monitoring and Maintenance
M-WV	Monitor – Well Vegetated
OU	Operable Unit
OM	Organic Matter
OW/EADA	Old Works/East Anaconda Development Area
PDP	Preliminary Design Package
POC	Point of Compliance

ppm	Parts per million
PRLU	Preliminary Remedial Land Unit
PRP	Potentially Responsible Party
PTSG	Planting of Trees, Shrubs, and Grasses
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAG	Remedial Action Goal
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RD	Remedial Design
RDU	Remedial Design Unit
RDWP	Remedial Design Work Plan
RFC	Request for Change
RI	Remedial Investigation
ROD	Record of Decision
RRU	Reclamation Research Unit
SAP	Sampling Analysis Plan
SAR	Sodium Adsorption Ratio
SMP	Shoemaker McClean and Pratt
SPAOD	Superfund Planning Area Overlay District
SSR	Steep Slope Reclamation
STARS	Streambank Tailings and Revegetation Study
TI	Technical Impracticability
TSS	Total Suspended Solids
T6	Treatment to 6 inches
T12	Treatment to 12 inches
T18	Treatment to 18 inches
USFWS	U.S. Fish and Wildlife Service
µg/L	Micrograms per Liter
VI	Vegetation Improvement
WMA	Waste Management Area
WV	Well-Vegetated

REMEDIAL ACTION WORK PLAN
RDU 1 – Stucky Ridge Uplands
ARWW&S Operable Unit

1.0 INTRODUCTION

This Remedial Action Work Plan identifies the methods and procedures that will be followed for the implementation and management of the Anaconda Regional Water, Waste & Soils (ARWW&S) Operable Unit (OU) Uplands Remedial Action (RA) for Stucky Ridge. Due to the large size of the Stucky Ridge RDU (approximately 1,870 acres of uplands), it has been divided into 4 areas based on, but not limited to, topography, remedial action acreage and drainages to more effectively implement the RA and manage the RA. Performance of the RA for each of the 4 areas is described in this RAWP and where appropriate, construction information presented separately for each of the 4 areas (i.e., construction drawings, bill of materials). Information relevant to all of the areas is provided one time (i.e., specifications and construction QA procedures) to reduce repetitiveness in the document. The 4 RAWP areas are shown separately on Sheet 1 of the Drawings in Appendices A-1 through A-4. In addition, this RAWP also sets forth task-specific methods or approaches and schedules and other provisions to comply with performance standards and other criteria required by the Record of Decision (ROD) (EPA, 1998) and identified in the RDU 1 Final Design Report (Atlantic Richfield, 2005a).

1.1 Final Design Report/Remedial Action Work Plan Organization

RDU 1 – Stucky Ridge Uplands is one of 16 RDUs designated at the ARWW&S OU. A Final Design Report (FDR)/Remedial Action Work Plan (RAWP) will be prepared for each RDU. The site-wide design also includes several site-wide Management Plans that affect the implementation of the Remedial Action (RA) for RDU 1. These site-wide documents are as follows:

- Site Management Plan;
- Institutional Controls Management Plan (ICMP);
- Monitoring and Maintenance (M&M) Plan;
- Data Management Plan (DMP).

The design for RDU 1 is included in two documents. The FDR/ RAWP for RDU 1 includes:

FDR The FDR provides the remedial action objectives (RAOs), Selected Remedy, and remedial requirements of the ARWW&S OU ROD, summarizes the results of design investigations and analyses that have been completed since the ROD; presents the basis of design for each remedial design component(soils, surface water, ground water, and institutional controls), and identifies key design criteria and ARARs.

The FDR also, summarizes the existing data, discusses and evaluates remedial alternatives evaluated during the design, and presents the final design, and design

drawings (scales of 1"=500', 1"=600', 1"= 750' and 1"=1000'). An analysis of how the design is expected to achieve RAOs and performance standards is also presented in the FDR.

RAWP The RAWP work plan identifies project roles and responsibilities; procedures to implement the RA; specifications, a quality assurance plan, and construction drawings (scale of 1"= 500'); pre-construction activities; construction tasks; monitoring, inspection, and maintenance requirements. RDU 1 has been divided into 4 separate work areas based on hydrology, remediation acreage and treatments. All four work areas are addressed in this RAWP.

1.2 Remedial Action Work Plan Organization

This RAWP has been organized into the following sections:

- Section 1 provides a brief introduction to RDU 1 and the associated organization of the RDU 1 RD/RA;
- Section 2 provides a description of the Project Management and associated activities for the RDU 1 RA;
- Section 3 describes the activities that will occur prior to commencement of the RA within RDU 1;
- Section 4 identifies the RA for contaminated soils within RDU 1;
- Section 5 identifies the RA for surface water within RDU 1;
- Section 6 identifies the RA for ground water within RDU 1;
- Section 7 identifies institutional controls associated with the RDU 1 RA;
- Section 8 identifies post-RA reporting requirements;
- Section 9 discusses monitoring and maintenance requirements;
- Section 10 discusses delisting/deletion regulations and guidance; and
- Section 11 lists the references cited in this report.

This RAWP includes the following Appendices containing information supporting the RA:

- Appendix A-1 through A-4 – Construction Drawings and Design Information are provided in separate appendices for each RAWP Area
- Appendix B – Technical Specifications
- Appendix C – Construction Quality Assurance Plan (CQAP)
- Appendix D – Construction Storm Water Erosion Control Plan (SWECP)
- Appendix E-1 through E-4 – Bill of Materials are provided in separate appendices for each RAWP area

2.0 PROJECT MANAGEMENT AND COMMUNICATIONS

The purpose of this section of the RAWP is to provide guidance to efficiently manage the RA, including defining lines of authority, communication, project coordination, project meetings and submittal requirements. The roles and responsibilities of the organizations involved in the RA are described in Section 2.1.

2.1 Project Organization, Roles and Responsibilities

The organizations that will be involved in the RDU 1 RA include the following:

- EPA Region VIII;
- Montana DEQ;
- Atlantic Richfield;
- Private Landowners;
- QA/QC Oversight Personnel; and
- Construction Contractor(s).

The EPA, in consultation with DEQ (the Agencies), will have the authority for final approval of the RA. The project CQAP is presented in Appendix C. Atlantic Richfield will periodically provide QA/QC results and other information to the Agencies to keep them informed of the progress of the RA. The Agencies will also be responsible for reviewing project schedules and submittals provided to them by Atlantic Richfield or its designated representative.

Atlantic Richfield or its project representative will be responsible for providing construction management and verifying that the RA complies with this RAWP and the construction performance standards. Atlantic Richfield or its project representative will manage the project to focus on attaining the objectives outlined in the FDR. Atlantic Richfield and EPA will coordinate to provide all project related communications to Federal, State and local agencies, the public, the landowner, as appropriate, and all other involved or interested parties. Remedial Action activities will be coordinated by Atlantic Richfield or its project representative to adhere to the agreed upon schedule.

The QA/QC Oversight Personnel will report directly to Atlantic Richfield and will provide technical assistance on the project by performing QA/QC oversight of the Construction Contractor's work. The QA/QC Oversight Personnel will evaluate the Contractor's compliance with the RAWP and applicable site performance standards. Any deviations from this work plan will require the approval of both Atlantic Richfield and EPA.

The Contractor(s) will be responsible for performing the designated activities associated with the RA in accordance with this plan and other applicable documents. The Contractor will be responsible for communicating directly with the Atlantic Richfield project representative and or QA/QC Oversight Personnel on all issues and concerns. The Contractor will be responsible for scheduling the project activities with its Subcontractors to complete certain work tasks by the associated milestone dates. The Contractor will designate a primary contact person as the Contractor's site representative.

This person will have full authority to make all necessary field decisions and to direct the work for the Contractor.

The Design Engineer will report directly to Atlantic Richfield and will provide technical assistance throughout the duration of the project. The Design Engineer will verify the Contractor's compliance with the Construction Drawings (Appendix A) and the Technical Specifications (Appendix B).

2.2 Property Owner

Land within the area addressed by this RAWP is owned by multiple private parties, government entities and Atlantic Richfield. Atlantic Richfield Company is the responsible party for implementing the remedy within RDU 1. Land ownership is shown on Sheet 3 of the Construction Drawings provided in Appendix A of this RAWP. Atlantic Richfield Company will coordinate with and disseminate information to the landowners regarding remedial activities. All correspondence from landowners to the Agencies related to the project shall be directed to Atlantic Richfield Company.

Each landowner will be required to grant access for RA implementation and monitoring and maintenance. A Landowner Agreement will be executed between Atlantic Richfield and each affected landowner. This agreement will allow Atlantic Richfield Company and the Agencies access to the property for remedial action implementation and post-implementation monitoring and maintenance. The Agreement will also specify post-RA land management requirements (i.e. grazing, weed control, various County ordinances) for land use and identify post-construction landowner requirements to ensure that the remedy is not adversely impacted.

2.3 Project Meetings

A pre-construction conference involving representatives from Atlantic Richfield, EPA, DEQ, the QA/QC Oversight Personnel, the Design Engineer (as necessary), the Contractor and affected landowners (as necessary) will be scheduled before initiating any work at the site. The purpose of this pre-construction meeting is to assure that all parties understand their respective responsibilities and the procedures that will be used to assure efficient completion of the work. The meeting will discuss scheduling (including critical milestone dates), submittal procedures, recordkeeping, use of premises, site security, health and safety procedures, material and equipment delivery and staging/storage requirements/procedures.

Progress meetings involving representatives from Atlantic Richfield, EPA, DEQ, the QA/QC Oversight Personnel, the Design Engineer (as necessary), the Contractor's site representative and affected landowners (as necessary) will be held weekly at the job site. The progress meetings agenda will include, at a minimum, the status of work items initiated to date, scheduled work items for the following week, problems encountered and proposed solutions, and any health and safety or historical issues that have arisen in the past week or issues that are pertinent to the work scheduled for the following week.

2.4 Documentation of the Remedial Action Implementation

The RA will be documented and controlled via the Drawings (Appendices A-1 through A-4), Technical Specifications (Appendix B), CQAP (Appendix C), approved design change procedures, reporting and record keeping and information /data storage.

2.4.1 Construction Drawings and Technical Specifications

Construction Drawings for each of the 4 RAWP areas in RDU 1 are attached and presented separately in Appendices A-1 through A-4. The Technical Specifications are provided in Appendix B. The specifications and drawings provide the requirements for how the design is to be implemented. The CQAP provided in Appendix C describes the oversight observations and measurements that are required to ensure the design is implemented according to the requirements set forth in the specifications and on the drawings. Documentation of the adherence to the design and specifications is provided in the CQAP and is discussed below.

2.4.2 Procedures to Implement the Construction Quality Assurance Plan

The Uplands CQAP presents QA/QC requirements for general construction procedures such as mobilization, construction BMPs, lime amendment, tillage, organic matter amendment, fertilizing, seeding, dust control, and general requirements for RDU 1 Areas 1-4. The CQAP is provided as Appendix C. Also presented in the CQAP are requirements associated with controlling construction-related oils, fuels and other materials. The QA/QC Oversight Personnel will provide oversight of the contractor during construction to assure compliance with all sections of the CQAP.

2.4.3 Design Changes

Changes in implementation or how the RA is performed are considered minor and generally do not require formal approval. Changes to the design require formal approval. All changes to any portion of the design must be clearly delineated and described on a Request for Change (RFC) form provided in the CQAP. These completed forms will be used to update the As-Built Drawings, to provide a clear record of all field modifications, identify the exact location and reason for the modifications, and suggested alternatives and solutions to field complexities. Copies of RFC forms will be maintained at Atlantic Richfield Company's project trailer office and the Butte, Montana main office.

2.4.3.1 Design Change Category

2.4.3.1.1 Field Changes

Minor changes in the performance of the RA do not require the approval of Atlantic Richfield or the Agencies and can be documented in the field log book. This could include the location of access roads, amendment stockpile locations, weed spraying chemicals, etc.

2.4.3.1.2 Design Changes

All design changes require the approval of Atlantic Richfield Company and the Agencies and will be identified on a RFC form (See Uplands CQAP in Appendix C of this RAWP). These include changes to locations of remedial technologies, use of different remedies, seed mix changes, etc.

If design changes are approved verbally by the Atlantic Richfield Construction Manager and the Agency oversight, then the change must be documented in the Daily Construction Report and discussed in the As- Built report (RACCR).

2.4.3.2 Description of Change

Detailed notes should be made in the logbook, and digital photographs will be added to provide justification for on-site minor changes. When approval is sought for design changes, an RFC form will accompany the aforementioned documentation. All change requests submitted will be registered, and a RFC form will be issued accepting all changes, making modifications, or refusing the request.

2.4.3.3 Affected Documents

As-Built drawings should be updated as changes are planned and implemented. The RFC provides a mechanism to transfer changes up the chain of documentation.

2.4.3.4 Approval Process

The completed RFC will be submitted to the Atlantic Richfield representative, reviewed, approved and signed. The RFC will then be forwarded to the Agency oversight person and the Agency project manager for approval, modification and/or rejection. The signed RFC will then be returned to the Atlantic Richfield project representative.

2.4.4 Reporting and Recordkeeping

The RA contractor will record on a daily basis the following information, when applicable, during RA:

- Onsite equipment and personnel;
- Safety Incidents including preventive measures implemented;
- Material delivery and usage;
- QA/QC on required materials; and
- Laboratory analytical results on construction materials.

The QA/QC Oversight Personnel will perform various record-keeping duties and will be responsible for maintaining a complete and accurate record of all significant field observations, inspections and all field and/or laboratory testing and results. These records will be kept onsite for EPA review. The record-keeping activities will include, but are not necessarily limited to, the following:

- **Logbooks**. Logbook entries will document significant activities, observations and deviations from the Drawings of Specifications, key information regarding field sampling, safety issues, measurement and testing, photographs taken, and the topics/results of any significant meetings/discussions.
- **Quality Assurance Testing Documents**. Instrument calibration forms, field and laboratory measurement and sampling forms, sample logs, chain-of-custody forms, and any other documents related to quality assurance testing will be kept onsite with the Daily Project Logs. Sample forms for non-environmental sampling and testing are included in the CQAP. Summaries of

relevant quality assurance and laboratory tests will be included in the Daily Project Logs.

- **Other Documentation**. Other documentation required may include, but is not limited to: material compliance certifications (as provided by the Contractor); materials testing results; manufacturer's recommended installation or operating instructions; site walk and site visit records; and signed pre- and post-construction landowner approval inspection records.

The Atlantic Richfield Company will submit to the Agencies a monthly report of construction activities during RA phases. The monthly report will include, at a minimum, the following items:

- Monthly progress;
- Monthly quantities and production;
- Schedule modifications;
- Schedule projections; and
- Other appropriate information.

Upon completion of remedial activities within a RAWP area, a RA Construction Completion Report (RACCR) will be completed for each Stucky Ridge Area 1 through 4 and submitted to the Agencies.

2.4.4.1 Remedial Action Project Files

The Daily Project Logs will be stored onsite in a binder to provide a readily available record of construction activities. These Daily Project Logs will be included as an appendix to the final "As-Built Completion Report" to provide a chronological description of construction activities through completion.

2.4.4.2 CQAP Data Management

All data collected as a part of CQA activities will be attached to the monthly reports and filed with them or provided at weekly progress meetings.

3.0 PRE-CONSTRUCTION ACTIVITIES

The following activities will be performed prior to starting RA construction.

3.1 Pre-Construction Site Walk

As determined at the pre-construction conference and outlined in the SMP a site walk between Agency personnel and Atlantic Richfield will be performed to review the design and identify any changes or clarifications required prior to implementation. Polygon boundaries are based on current vegetation and landform. Identified polygon boundaries will be the basis of boundary evaluation during Pre-Construction Site Walk at which time boundaries may change to reflect "in–the-field" conditions. The site walk will also include addressing any issues associated with the RD, evaluating access areas, erosion control concerns, remedial boundaries (i.e., steep slope areas), amendment requirements (i.e., organic matter), weed problems that may require treatment, and any other factors

that may influence the RA or the manner in which it is implemented. Drawings at a scale of 1"=200' will be provided for the Pre-Construction Site Walk.

3.2 Landowner Agreements

A landowner Agreement Form will be executed between Atlantic Richfield Company and each affected landowner. This agreement must be in place prior to construction activities and will allow Atlantic Richfield Company and the Agencies access to the property for remedial action implementation and post-implementation monitoring and maintenance. The Agreement will also specify post-RA land management requirements (i.e. grazing, weed control, various County ordinances) for land use and identify post-construction landowner requirements to ensure that the remedy is not adversely impacted.

To the extent possible, remedial action activities will be coordinated with individual landowners to account for the intended land use (i.e., development of landowner specific seed mixes, integration of site specific structures such as roads, etc). These issues will be agreed upon with the landowner prior to construction and in accordance with the Landowner Agreements.

Landowners are required to manage their property in accordance with all existing state and county laws and ordinances (i.e., weed control). During implementation of the RA and until performance standards have been attained, Atlantic Richfield shall coordinate with landowners to manage the property in a manner consistent with success of the remedy. Upon completion of RA construction activities and achievement of performance standards, as outlined in the Final Vegetation Management Plan, property management reverts back to the landowner to manage the property so as to minimize erosion or degradation of the remedy (i.e. vegetation cover). Each landowner will be required to grant access for RA implementation and monitoring and maintenance. The Landowner Agreement may contain additional details regarding landowner requirements. Atlantic Richfield may arrange for landowners to participate in certain maintenance activities.

Future development of the property must comply with local and state building/development codes and requirements identified in the Anaconda Deer Lodge County (ADLC) Master Plan (ADLC, 1992a) and the Development Permit System (DPS) (ADLC, 1992b) and any revision to those documents.

3.3 Wetlands and Historical and Cultural Resources

Wetlands, historic structures and cultural resources will be protected during RA implementation. During the pre-construction conference, site assessments for evaluation of these resources will be scheduled. Prior to commencing with remedial activities, assessments of the construction area will be performed during the site walk to evaluate any wetland or historic areas that could be impacted. Evaluation of wetland and historic areas are discussed in greater detail in the following paragraphs.

3.3.1 Wetlands

Several areas within the Stucky Ridge RDU have been delineated as wetlands. *ARWW&S OU Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area;* (AERL, 1999). Remedial activities are not anticipated within wetland areas under RDU 1 – wetland areas will be avoided to the

extent practicable. Wetland areas may be flagged prior to remedial activities if adjacent to a work area to prevent impact or disturbance to wetlands. Flagged areas will include a buffer distance as dictated by a qualified wetland specialist. Wetlands identified within Stucky Ridge Areas No. 1 through 4 are located in the riparian zones adjacent to the perennial streams Lost Creek and Warm Springs Creek. Wetland vegetation types include cattail (*Typha latifolia*) marshes, willow (*Salix spp.)* dominated shrub communities, several types of graminoid-forb meadows, streamside herbaceous communities and aspen (*Populous tremuloides*) thickets. Wetland areas in each RAWP are shown on Sheet 4 in Appendices A-1 through A-4 to this RAWP and are further discussed in the Wetland and Threatened/Endangered Species Inventory with Determination of Effective Wetland Areas report. If additional identification of wetland areas is required prior to RA activities, identification and flagging will be completed by a qualified wetland specialist. The wetland assessment will follow the previously approved Upper Clark Fork River 4-step Wetland Mitigation Process. Atlantic Richfield Company will ensure that all contractors follow best management practices to minimize soil disturbance and erosion and to maintain bank stability in wetland areas during construction. Loss of wetland habitat by wildlife, due to noise and construction activities, will be short-term. No long-term impacts to wetlands will occur as a result of the remedial activities.

3.3.2 Historic Resources

There are no identified historical features within Stucky Ridge Area No. 1. However, known historic structures and features located within Stucky Ridge Area No. 2, 3 and 4 includes the flue from the Upper and Lower Works smelters that were historically located on Stucky Ridge. Approximately 27 acres within Area No. 2, 66 acres within Area No. 3, and 66 acres within Area No. 4 have been designated as "Historic" locations and will not be disturbed during implementation of the remedial action. Further evaluation of these historic areas will be performed during a site assessment by qualified personnel prior to commencement with construction activities in each area.

It is anticipated that no other historical features will be identified during the RA; however, if features are identified, and pursuant to ARARs, the following procedures will be initiated:

1. Atlantic Richfield Company and Agency construction oversight personnel shall be immediately contacted;
2. The Atlantic Richfield Company's project manager shall be immediately contacted by Atlantic Richfield's construction oversight personnel;
3. RA activities in the immediate vicinity of the identified feature shall be halted. Construction elsewhere on the project may continue; and
4. The requirements of the Regional Historic Preservation Second Programmatic Agreement (ARCO, 1994) and any subsequent amendments will be met.

3.3.3 Cultural Resources

A Class I cultural resource inventory (file search) will be conducted to summarize the types of previously recorded sites that exist in the vicinity of the work areas where

ground disturbing activities will take place. It is anticipated that no new cultural features will be identified during the RA; however, if features are identified, and pursuant to ARARs, the following procedures will be initiated:

1. Atlantic Richfield Company and Agency construction oversight personnel shall be immediately contacted;
2. The Atlantic Richfield Company's project manager shall be immediately contacted by Atlantic Richfield's oversight personnel;
3. RA activities in the immediate vicinity of the identified feature shall be halted. Construction elsewhere on the project may continue; and
4. The requirements of the Regional Historic Preservation Second Programmatic Agreement and any subsequent amendments will be met.

4.0 CONTAMINATED SOILS REMEDIAL ACTION

4.1 Site Access

Primary access to RAWP Areas No. 1-4 will be obtained from Lost Creek Road through private properties on the northern portion of the project. Secondary roads that are created during the remedial activities shall be maintained by the Contractor. All secondary roads shall be reclaimed unless otherwise specified by Atlantic Richfield Company and/or the affected landowner. All secondary roads used during implementation of remedial activities are considered temporary access roads unless approved by Atlantic Richfield Company and/or the affected landowner. Security for construction sites and staging areas will be provided by the RA contractor. This includes the construction and maintenance of fences and gates where necessary, as well as personnel to control access points. The Agencies and Atlantic Richfield Company retain the right to access any site. Atlantic Richfield will keep copies of all necessary keys for such use.

4.2 Site Preparation

Weed spraying may occur before site preparation activities, as necessary, and to the extent that it will not impact existing desirable vegetation or result in residual impacts to seeded or planted species. Site preparation activities shall include, but not be limited to, mobilization of equipment and materials, stockpiling amendment, construction of access roads, as necessary, and placement of temporary erosion controls (e.g. silt fence around staging areas).

4.2.1 Weed Spraying

To the extent possible, weed spraying activities shall be coordinated with the landowner so that it can be conducted prior to any site preparation activities typically in the spring/summer months prior to any remedial activity. The types of chemicals will depend on the noxious weed species present and any state or county listed noxious weed identified within the work area will be sprayed. It is anticipated that leafy spurge, spotted knapweed, and Canada thistle are the most likely to be problematic. Prior to implementation of remedies, weed control programs may be implemented within treatment areas, as necessary. Any herbicides used in this program will not have residual

effects that could adversely influence the germination establishment and growth to seeded or planted species or impact existing desirable vegetation.

4.2.2 Road Improvements

Primary access to remediation areas within RDU 1 will be through existing roads (i.e., Lost Creek Road). Temporary access roads will be needed from these primary access points for delivery of amendments and equipment. However, designated haul roads and routes will not be required nor are rigid specifications required for the construction of these access roads. The RA will be performed with agricultural equipment capable of traveling cross-country. In areas where temporary access must be constructed or in locations where previous agreements with landowners designate construction of an access road, these roads will be constructed using standard practices and procedures. QA/QC Oversight Personnel responsibilities include monitoring road for dust control.

4.2.3 Clear and Grubbing

Limited clearing and grubbing of vegetation debris will be performed within the four RAWP areas and will consist of that only necessary for access roads, staging/amendment storage areas or clearing of dead debris to allow for implementation of the remedial action (i.e. T6 or T12). To the extent possible, live vegetation will be preserved during construction related activities. LT areas will not be cleared and grubbed.

4.2.4 Grading

Site grading will be conducted, as necessary, for construction of staging areas for protection of surface water run-on/run-off. Grading will also be performed prior to tillage and steep slope activities in areas where existing erosion rills/gullies are sufficiently deep and pervasive that they serve as a limitation to amendment application and do not allow for effective and efficient tillage of the soil. Deep primary drainages will not be graded. For non-SSR areas, rills and gullies will be filled or smoothed as determined necessary by the contractor in order for equipment to implement the remedy. This may be accomplished during the pre-till but also may require the use of dozer/blade for more severe gullies (i.e. deeper than 12”). Grading of rills and gullies within the construction areas will be evaluated during the pre-construction site walk to identify areas where grading may be required for implementation of the RA. To the extent possible, grading activities will be performed during clearing and grubbing of vegetation debris and shall work within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation. The RA contractor will be responsible for monitoring and verifying that site contouring is performed to the appropriate lines and grades, and that materials are placed in accordance with the Drawings and Specifications.

4.2.5 Construction BMPs

Placement of construction BMPs (e.g. silt fence) shall be completed in areas of concentrated flow that could impact Lost Creek or Warm Springs Creek. BMPs will be implemented when construction operations are in progress in and around natural drainages. During site work activities, standard BMPs will be followed to divert storm water around the work area and to minimize storm water runoff from transporting

sediments down-gradient to the extent practicable. These measures may include upgradient berms, straw bale check dams, temporary ditches and/or silt fence. See the Uplands CQAP (Appendix C of this RAWP), and the Construction Storm Water Erosion Control Plan (Appendix D of this RAWP) for additional details.

4.2.6 Preservation of Existing Vegetation

Areas of existing trees and vegetation, as determined in the field and/or preconstruction walkthrough, will be maintained during implementation of the RAs, to the extent possible. As necessary, improvement or enhancement of these areas will be performed to achieve compliance with performance standards. The species present within these areas have been used as guidance for development of the design. Emphasis shall be placed on mature vegetation given the time required to grow to maturity and on preservation of native grasses and forbs. Forbs, in particular are difficult to establish from seed. Tilling activities will be implemented within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation. Tillage will take place up to and adjacent to well vegetated areas. Tillage will be performed up to the edge of root mass for trees and shrubs not cleared and grubbed. To the extent that safety is not compromised and existing desirable vegetation is not impacted, tillage areas will overlap into adjacent polygons of good vegetation.

4.3 Material Storage

Bill of Materials identifying material quantities and treatment acreages in each RAWP area are presented in Appendices E-1 through E-4. Data for development of the lime rate and all lime rate calculations for all Stucky Ridge areas are provided in Appendix A – Table A-3 and rock content calculations are shown in Appendix A – Table A-4 of the Stucky Ridge FDR. Lime rate requirements and associated rock contents for correction of the lime rate for all RAWP areas are included separately on the attached drawings (Sheet 7 in Appendices A-1 through A-4).

Remediation of all four RAWP areas in RDU 1 will require use of lime, fertilizer and organic amendments, as necessary, to enhance the establishment of vegetation. Amendments will be stockpiled in primary staging locations and moved to areas of implementation immediately prior to remedial activities. The RA contractor will be responsible for identifying these areas and access to them in consultation with Atlantic Richfield and the affected landowner.

Dust and erosion control methods are provided in the Specifications and CQAP. The RA contractor will perform dust control in accordance with the Specifications to minimize fugitive dust emissions. Atlantic Richfield Company's IQAT representative will also verify that dust control is applied to the appropriate locations.

Based on previous sampling results, specific air monitoring is not required for this work. Best management practices will be followed to control fugitive dust, and maintain compliance with State ambient air quality regulations. Fugitive dust control measures that may be employed during the RA include:

- Watering haul roads;
- Vehicle speed restrictions;

- Avoiding lime activities during periods of high winds;
- Placement of covers (tarps) over lime stockpiles; or
- Minimizing area of disturbed land.

The need for dust suppression will be determined based on visual observations during construction activities.

4.4 Sequencing

The sequencing of revegetation activities for all four RAWP areas in RDU 1 will begin with mobilization, site preparation, tilling, liming, fertilization, and seeding of specified areas (See Sheet 7 in Appendices A-1 through A-4). Weed spraying will be performed, as necessary during the appropriate time of year for the target weed species within the remediation area to the extent that construction activities or vegetation establishment will not be impacted. Herbicides used will depend on the specific noxious weed species and its location on the landscape. Weed spraying equipment will also vary based on the weed infestation and weed location. For example, back pack sprayers would be used for spot spraying on inaccessible areas whereas tractor mounted boom sprayers would be used in heavily infested flatter terrain. Planting of tree and shrubs will be performed in either the spring or fall depending on stock availability and project scheduling and will typically be the last RA activity implemented.

Possible sequencing interruptions may occur due to weather conditions or construction problems that delay scheduled weed spraying, lime amendment application, or seeding. If weed spraying delays occur due to rain or wet weather conditions prior to the RA, areas may require a more stringent post-remediation weed control effort. Species (Specification 02940-Seeding) should be seeded from October 1st through June 15th. After these dates, it is generally undesirable for seeding grass/forb seed mixes. If, for some reason, an area is not seeded during the optimum dates, then seeding will be postponed until the next available planting/seeding time. Tilled areas that are not seeded due to missing the above time constraints may require summer erosion control protection. These areas shall be seeded with an annual cover crop of barley or other suitable species (annual rye) at 10 pounds of live seed (PLS) per acre.

4.5 Soil Treatment

T12 (Tillage to 12 inches depth). Tillage to 12 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels in soils cannot be reduced to less than the relevant action level through T6. Tillage of soils to a 12-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 12 inches will reduce metals concentrations by mixing the upper soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T12 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7 in Appendices A-1 through A-4. Lime rates and associated calculations for areas requiring lime are provided in Table A-3.

Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 12 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval, and greater than 6.0 s.u. in the 6 to 12-inch interval.

Following implementation of the T12 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis. Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval. Following tillage, Polygon OWSR-004.04, approximately 36 acres, will receive 6 inches of coversoil from an approved borrow source and shall then be fertilized and seeded. **There are an estimated 918 acres of T12 within RDU 1.**

T6 (Tillage to 6 Inches). Tillage to 6 inches, with or without amendment, is the objective of this remedial action alternative and is appropriate where contaminant levels are located in the upper soil layer. Tillage of soils to a 6-inch depth will be accomplished by use of agricultural implements (i.e. Rhome Disc) (See Specification Section 02910 – Tillage and CQAP Section 02010 – Mobilization). Tilling to 6 inches will reduce metals concentrations by mixing the surface soil layers with the lower soil layers to meet the applicable human health arsenic action level and provide a suitable growth medium. Associated lime application rates and predicted resulting COC concentrations within the tilled interval for areas requiring T6 are shown in Table A-1 Design Criteria Summary Tables (Appendix A). Predicted post-tilling arsenic concentrations are provided on Sheet 7 in Appendices A-1 through A-4. Lime rates and associated calculations for areas requiring lime are provided in Table A-3. Prior to lime application and incorporation, the area will be pre-tilled one time to a depth of 6 inches to loosen the soil profile (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment). No lime incorporation will be performed in areas to be tilled where the existing soil pH (based on the preponderance of the data) is greater than or equal to 6.5 s.u. in the 0 to 6-inch interval.

Following implementation of the T6 remedial action, the area shall be fertilized and seeded using a standard fertilizer rate and upland seed mix consisting of species that have been previously demonstrated as successful at other remediation projects (See Specification Sections 02940 – Seeding and 02960 – Fertilization and CQAP Section 02900 – Revegetation or other seed mix as modified/requested by the landowner). Areas with good vegetation will be avoided during tillage. The use and need for organic matter (OM) amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis. Site-specific factors, such as the observance of the original A-horizon, will be used to evaluate the need for OM. In areas where OM is determined

to be required, OM will be incorporated into the 0-6 inch interval. Following tillage, Polygon OWSR-004.02, approximately 8 acres, will receive 6 inches of pit run gravel. This area is a Facility-Junk Yard (acreage is not included in T6 acreage total) and will continue to be operated as a Facility-Junk Yard. Tillage to 6 inches is required to reduce arsenic concentrations to less than 500 mg/kg. **There are an estimated 706 acres of T6 within RDU 1.**

Tilling activities will work within equipment and safety limitations as well as around areas of existing trees and acceptable vegetation to limit impacts and preserve the desirable vegetation.

OM (Organic Matter Amendment). The use and need for organic matter amendment of soils within areas remediated via tilling will be evaluated on a polygon-by-polygon basis. Site-specific factors will be used to evaluate the need for OM. In areas where OM is determined to be required based on the absence of an A-horizon, OM will be incorporated into the 0-6 inch interval. The OM amendment shall have a 1 inch maximum particle size. Any particles larger than 1 inch will not be considered in the determination of OM content. The following criteria were used to determine when the use of OM is appropriate:

- Throughout the soil profile where elevated metals (arsenic greater than 1,000 mg/kg) are present following mixing and reduction.
- Where a continuous A-horizon can not be identified. (A visually identifiable soil A-horizon is defined as being in the range of four to six inches with the soil exhibiting a dark soil color consistent with conventions of soil taxonomy.)

The amount of OM amendment required for a given polygon will be determined prior to tilling during remedial action. The OM content of the soils will be determined by observation of a series of hand dug pits (one per 10 acres) in tillage areas by Agency and Atlantic Richfield representatives prior to implementation of the remedy. If a continuous A-horizon cannot be identified, the following approach shall be utilized to determine OM content:

1. For areas receiving LT, T6 and T12 remediation, one composite sample consisting of at least 5 sub-samples for the 10-acre grid will be collected prior to remedial action from the interval to be tilled (i.e., 0- to 6-inch interval for T6 and LT, and 0- to 12-inch interval for T12) and analyzed for organic matter content using the Walkley Black Procedure.

   Based on analyses, the OM content of the upper six inches of the soil profile within tillage areas, where OM is required, will be adjusted to achieve 1.5 percent OM in the top six inches based on dry weight or 3% throughout the soil profile in the case that the soil arsenic concentration cannot be reduced via tilling to below 1,000 mg/kg.

2. For areas receiving T18, organic matter amendment shall be added at a rate of 1.5% (dry weight) to the 0- to 6-inch profile.

If required, OM amendment will be incorporated following lime application (See Specification Section 02910 – Tillage and CQAP Section 02245 – Lime Treatment) prior

to seeding. Application of OM will be performed in accordance with Specification Section 02970 – Organic Amendment and Mulching and CQAP Section 02970 – Organic Amendment. The need for organic matter will primarily be determined during the site walk.

In addition, organic matter may be added in other areas where it is determined by Atlantic Richfield that organic matter addition would facilitate enhanced establishment or to jumpstart vegetation establishment (i.e., in drainages, fluvial outwash areas or areas where COCs are determined to be at levels that may influence normal vegetation establishment).

4.5.1 Mulch

Transition Zones, defined as areas between a SSR area and an upgradient treatment area (See Section 4.7) and areas in close proximity to public right-of-ways (i.e. adjacent to Lost Creek Road) may be straw mulched/crimped at a rate of approximately 2,000 pounds per acre (one ton per acre) to provide protection against soil erosion during establishment of vegetation in the tilled areas, as appropriate. These areas will be delineated during the site walk.

4.5.2 Seedbed Preparation

Seedbed examination and preparation are described in Specifications 02940 Seeding Part 3. Equipment may include agricultural type tractor, standard agricultural disks, harrows, or plows needed to till the soil at a minimum depth of 6-inches. Seedbed preparation will be performed following fertilizer application so that fertilizer shall be incorporated into the upper 3 to 4-inch soil profile.

4.5.3 Amendments

Remediation of RDU 1 RAWP Areas No. 1-4 will require use of amendments including lime, fertilizer and in some areas, organic matter, to enhance the establishment of vegetation. Amendments required on a polygon by polygon basis are identified on Sheet 7 of the Construction Drawings provided in Appendices A-1 through A-4.

4.5.3.1 Lime

Tillage areas where lime is required to neutralize soil acidity will be limed using the maximum lime rates for the polygons as presented on Sheet 7 of the Construction Drawings in Appendices A-1 through A-4. The lime rates presented on Sheet 7 (Appendices A-1 through A-4) will be corrected for lime quality and minimum rock content (identified on Sheet 7) prior to implementation. In Stucky Ridge Area No. 1, approximately 425 acres of T6 and T12 treatment areas will receive lime amendment. In Stucky Ridge Area No. 2, approximately 222 acres of T6 and T12 treatment areas will receive lime amendment. In Stucky Ridge Area No. 3, approximately 559 acres of T6 and T12 treatment areas will receive lime amendment. In Stucky Ridge Area No. 4, approximately 252 acres of T6 and T12 treatment areas will receive lime amendment. The technical requirements for use lime amendment are presented on Sheet 7 (Appendices A-1 through A-4) for each RAWP Area and in the Specifications provided in Appendix B of this RAWP.

4.5.3.2 Fertilizer

Fertilization rates are based on typical rates already applied at other approved Atlantic Richfield Company revegetation projects. All tillage areas within this project area will be fertilized at the same rate of 500 pounds per acre (12% N/ 16% P2O5/ 30% K2O). No fertilizer will be applied within several feet of saturated soils (wetland) or inundated areas (edge of water/inside dry stream channel) to minimize the potential for release of fertilizer to surface waters. Fertilizer will be broadcast over the tilled soil surface and incorporated after tilling and prior to seeding during the seedbed preparation. The fertilizer will be broadcast spread, either with a tractor or by hand using a hand operated cyclone spreader and incorporated during seedbed preparation using a chisel plow or other appropriate method of preparing the tilled surface for seeding. Fertilization specifications are presented in Specification 02960-Fertilization (Appendix B).

4.5.3.3 Organic Matter

The need for organic matter amendment within areas to be remediated using T12 or T6 will be determined during the site walk with Agency personnel to assess the presence of the soil A-horizon within tillage areas. A visually distinct soil A-Horizon is defined as being in the range of four to six inches with the soil exhibiting a dark soil color consistent with conventions of soil taxonomy. It is anticipated that Organic Matter will not be required in LT areas. It is anticipated that some tillage areas (i.e. T12, T6) will require the addition of organic matter. In areas where OM is determined to be required, OM will be incorporated into the 0-6 inch interval to achieve a final organic matter content of 1.5%.

OM amendment shall have a 1 inch maximum particle size. Any particles larger than 1 inch will not be considered in the determination of OM content. All amendment material will be visually inspected by the QA/QC Oversight Personnel to ensure proper stockpiling and storage measures are followed as described in the Technical Specifications (Appendix B). In addition, periodic sampling will be performed to assess the quality of stockpiled material in accordance with appropriate CFRSSI SOPs (ARCO, 1992).

4.5.4 Seeding

One primary seed mix, has been developed for tillage areas within Stucky Ridge Areas No. 1 through 4 based on site-specific hydrologic regimes, soil texture, slope and aspect This mix is Revegetation Mix 1 (Specification 02940-Seeding, Appendix B and Sheet 7 in Appendices A-1 through A-4).

Revegetation Mix 1 includes species that have been demonstrated to be successful at other areas of the Smelter Hill NPL Site and includes a mixture of rhizomatous and bunch grass species that will aid in reducing soil erosion. Revegetation Mix 1 contains species adapted to a variety of soil moisture and soil textures that will provide both short-term and long-term erosion control, soil stabilization and vegetation cover.

REVEGETATION MIX 1

UPLAND SEEDED HERBACEOUS SPECIES

(BASIC SEED MIX FOR UPLAND GRASSLAND AREAS)

Scientific Name	Common Name	Variety	Percent of Mix (Pure Live Seed Weight Basis)
Grasses			
Agropyron trachycaulum	Slender wheatgrass	Revenue	15
Agropyron smithii	Western wheatgrass	Rosanna	10
Agropyron dasystachyum	Thickspike wheatgrass	Critana	15
Agropyron spicatum	Bluebunch wheatgrass	Goldar	10
Elymus cinereus	Great Basin wildrye	Magnar	15
Poa ampla	Big bluegrass(1)	Sherman	14.5
Festuca ovina	Sheep fescue	Covar	10
Oryzopsis hymenoides	Indian ricegrass	Nezpar	5
Forbs/Subshrubs			
Artemisia frigida	Fringed sagebrush	NA	0.5
Achillea lanulosa	Western yarrow	NA	2.5
Linum lewisii	Common blue flax	Appar	2.5

Notes:

1. If unavailable or cost prohibitive, *Poa sandbergii*/sandberg bluegrass may be substituted at the same seeding percentage.

In areas receiving Revegetation Mix 1, a cover crop will be planted to provide interim protection during the establishment year, to help control wind and water soil erosion on disturbed areas, and to help combat establishment of weeds. Since cover crops compete for water, light, and nutrients, they must be compatible with the seedling forage. Areas will be seeded with an annual cover crop of Barley or other suitable species (annual rye). The cover crop will be incorporated into the seed mix at a rate of 10 pounds PLS/acre.

Seeding methods and procedures are presented in Specification 02940-Seeding. Polygons and the associated seed mix to be implemented within each RAWP area are shown separately on Sheet 7 and supplemental DCS sheets in Appendices A-1 through A-4. Acknowledgment of individual landowner seed mix requests will be addressed in the Landowner Agreement and will be incorporated into the drawings once identified.

Seeding equipment may include a custom seeder or any drill seeder that is approved by the Agencies and Atlantic Richfield Company field representatives. Two seeding methods will be used, as appropriate: broadcast seeding and drill seeding. Small areas

inaccessible to equipment and steep slope areas will be broadcast seeded by hand. Seeding of steep slope areas is discussed in Section 4.6. All tilled areas will be drill-seeded. Seeding methods and procedures are presented in Specification 02940-Seeding.

4.6 Steep Slope Reclamation (SSR)

Steep slope areas are identified by a pitch steeper than 3:1 (vertical to horizontal). The RDWP (EPA, 2000) identifies four types of SSR. The techniques to be implemented for SSR are:

1. SSR-1 – Broadcast seeding/fertilizing in conjunction with planting of trees and shrubs;
2. SSR-2 – Broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs that do not require mechanized equipment (e.g., brush boxes, straw bales, wattles, check dams and other BMPs);
3. SSR-3 – Broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins); and
4. SSR-4 – Broadcast seeding in conjunction with planting of trees and shrubs, implementation of on-slope BMPs requiring mechanized equipment (e.g., dozer basins), and slope regrading/recontouring.

For design and implementation purposes, the design drawings illustrate SSR remediation as specific activities or engineering controls, but the maps show only general locations and techniques to be implemented. Actual locations and SSR techniques will be determined during the "plan-in-hand" site walk based on site-specific conditions.

4.6.1 Woody Species Selection and Location

The primary component of all Steep Slope Remediation (SSR) Types is the planting of trees and shrubs and broadcast seeding of grasses. Trees and shrubs shall be planted on side-slopes of steep sloped areas to help stabilize the soil, reduce runoff velocity and to encourage establishment of woody species. To help reduce erosion and reduce runoff from the steep slope areas, on-slope BMPs (i.e., brush boxes, dozer basins) will be constructed, as appropriate. Woody species shall be planted in conjunction with the on-slope BMPs to help reduce soil erosion, increase evapotranspiration and re-establish vegetation on the side-slopes. Specification 02930-Planting of Trees and Shrubs provided in Appendix B identifies a comprehensive species list for PTSG plantings. Suggested species for the polygons within the project area primarily include chokecherry, currant and Woods rose as well as Rocky Mountain juniper, limber pine, Douglas-fir, Lodge pole pine and ponderosa pine. Chokecherry and currant will be concentrated in transition zones, (i.e. base of slopes or concave depressions and east/north facing slopes). Rocky Mountain juniper, limber pine, Douglas-fir, Lodge pole pine and ponderosa pine will be planted on other slopes. Woods rose will be concentrated on the lower portion of the slope on both warmer and cooler aspects to aid in soil stabilization. The planting density for trees and shrubs in the Upland areas is 450 stems per acre, plus 50 trees/shrubs per acre for the ten years following remediation. Tree/shrub plantings will

be inoculated with mycorhizzae and will receive Restoration Pak fertilizer ((11% N/17% P2O5/9% K2O) in each planting hole. In conjunction with planting of trees and shrubs, SSR areas will be broadcast seeded using a mix consisting of Great Basin wildrye, western wheatgrass, bluebunch wheatgrass, big bluegrass and sheep fescue at a broadcast seeding rate of approximately 25 pounds per acre. This seed mix is identified in Specification 02940-Seeding, in Appendix B.

To the extent possible during planting of woody species on side-slopes, small depressions or basins around the plantings will be created to help retain surface water and provide additional runoff control. In areas where planting of trees and shrubs is implemented in conjunction with brush boxes and dozer basins, these BMPs will help retain surface water. **The SSR polygons include an estimated 267 acres of RDU 1 Area No. 1, 204 acres in Area No. 2, 939 acres in Area No. 3, and 67 acres in Area No. 4.**

Designs for these areas are summarized in the Design Criteria Summary Tables (Appendices A-1 through A-4) and the polygon locations are shown on Sheet 7 of Appendices A-1 through A-4. PTSG methods and procedures are presented in Specification 02930-Planting of Trees and Shrubs in Appendix B.

4.7 Transition Zones

The Transition Zone is defined as the area between an upgradient hillside or hilltop (flatter than 3H:1V) treatment area (i.e. T6, T12, LT) where treatment ends due to slope steepness and the downgradient steep slope (as previously defined) located below the treatment area. Because vegetation in treatment areas may not be fully established for several years following treatment, it is necessary to construct temporary storm water BMPs to minimize potential erosion and sediment transport from the upgradient treatment area to the slope below. Although tillage equipment may not be able to operate safely in the Transition Zone, track-type tractor equipment such as dozers may be able to operate safely until the steepness of the slope exceeds 2H:1V as determined in the field. At the transition zone, if tillage is unable to extend to the start of the SSR area, dozers may be used to construct temporary BMPs such as dozer basins and temporary along-contour ditches, and to grade erosion rills and gullies, as determined in the field by construction oversight personnel. Areas of adequate existing vegetation or rock outcrops will be avoided. While Transition Zones are identified on Sheet 7 as linear zones between treatment polygons and steep slope reclamation polygons downslope of the treatment areas, the width of the transition zone is unknown and will ultimately be determined during construction when the tillage limits become known. Transition areas are only applicable to SSR polygons with a remedy of SSR-1, SSR-1/SSR-2, SSR-2, SSR-2/SSR-3, and SSR-3 with an adjacent upgradient tillage polygon.

If a transition area is able to be tilled it will be seeded and fertilized and is a likely candidate for mulch. On-slope BMPs, within the downgradient steep slope area, will be installed to impede surface water runoff. If SSR-3 and/or SSR-4 is the proper treatment, dozer basins will be installed to impede surface water runoff and the transition area will be seeded and planted with trees and shrubs. Of the 40 SSR polygons, 26 have transition areas associated with them.

4.8 Construction Quality Assurance

The Uplands CQAP presents QA/QC requirements for soil amendments, revegetation, storm water controls/BMPs and general requirements for work identified in this RAWP. The CQAP is provided in Appendix C of this RAWP. The Construction SWECP presents requirements to control erosion due to storm events during construction activities and also includes requirements for controlling construction-related oils, fuels and other materials. The Construction SWECP is provided in Appendix D. Additional discussion on storm water control as part the uplands RA is discussed in Section 5.0.

In-situ treatment in general involves tilling and mixing of in-place soil materials with amendment materials, as necessary, at specified application rates and mixing depths. The RA contractor shall verify that amendments (lime and fertilizer) are in compliance with the Specifications and Drawings in terms of product specifications, and that these materials are applied at the rates designated for various reclamation units, and using acceptable methodologies for calibration of equipment, incorporation, and in-place mixing. Atlantic Richfield's Oversight representative shall observe and verify the RA contractor's compliance with the Drawings and Specifications.

Atlantic Richfield's Oversight representative will perform monitoring during stockpiling of amendment materials to verify the RA contractor's compliance with location and storage protocol. Amendment materials will also be sampled periodically to verify that the material's quality complies with the requirements set forth in the FDR/RAWP and Technical Specifications. Sampling will be performed in accordance with appropriate CFRSSI SOPs.

Seeding of the revegetation areas will be monitored to ensure compliance with Specifications with regard to rate of seed and amendment application, and mulching requirements. The seedbed shall be inspected to verify it is suitable for planting. This inspection shall include verification that the soil is not too loose or overly compacted.

The following CQAP procedures will be followed in the implementation of the RA:

- Section 01000 General Procedures
- Section 01100 Record Keeping Requirements
- Section 01200 Logbooks
- Section 01210 Daily Project Logs
- Section 01400 Sample Identification and Tracking
- Section 02010 Mobilization
- Section 02110 Site Clearing
- Section 02120 Stripping
- Section 02205 Fill Materials and Placement
- Section 02207 Aggregate Materials

- Section 02211 Site Grading
- Section 02212 Dozer Basins
- Section 02222 Excavation
- Section 02241 Sampling Procedures
- Section 02245 Lime Treatment
- Section 02250 Ditch Construction
- Section 02255 Grade Control Structures
- Section 02256 Check Dams
- Section 02275 Riprap
- Section 02710 Geotextiles
- Section 02751 Culverts and Piping
- Section 02900 Revegetation
- Section 02935 Brush Boxes
- Section 02936 Willow Fascines and Live Stakes
- Section 02970 Organic Amendment
- Section 02980 BMPs Section 02120 Stripping
- Section 02205 Fill Material and Placement
- Section 02211 Site Grading
- Section 02212 Dozer Basins
- Section 02275 Riprap
- Section 02935 Brush Boxes
- Section 02936 Willow Fascines and Live Stakes
- Section 02970 Organic Amendment
- Section 02980 BMPs

5.0 SURFACE WATER REMEDIAL ACTION

5.1 Storm Water Management

Sediment and erosion control will be achieved primarily through revegetation efforts and the application of Storm Water BMPs and as necessary, implementation of engineered controls. The primary goal of the storm water BMP design effort in the Uplands RA is to develop methods to stabilize the erosion prone slopes and ephemeral intermittent tributaries or drainages to Lost Creek and Warm Springs Creek as necessary in order to reduce potential COC and sediment loads in storm water runoff. Control of storm water runoff has been divided into 3 areas. These three areas include 1.) Control of storm water

through Temporary Construction BMPs; 2.) Implementation of BMPs as part of the RA to control erosion/storm water runoff until vegetation becomes established and 3.) Construction of more-permanent engineered controls. The design elements are intended to reduce erosion of hillsides and drainages in order to protect the uplands remedies and reduce long-term Monitoring and Maintenance (M&M) requirements. These actions will subsequently reduce potential COC and sediment loads in the perennial streams. More information on Construction BMPs, Erosion BMPs, and engineered controls design is provided in Appendix B to the RDU-1 FDR.

The Surface Water RA has been developed to reduce erosion, promote permanent vegetation, and minimize COC runoff by employing one or more of the following BMPs, when appropriate:

1. Soil stabilization techniques such as slope grading, roughening, and serrating;
2. Grade control and check dams in tributary drainages:
3. Sediment barriers (i.e. check dams) and filters (i.e. brush boxes);
4. Minimal mulch/matting to provide temporary protection for establishment of vegetation in tributary drainages; and
5. Tilling and planting to re-establish or improve vegetation to reduce erosion.

Engineered controls have been designed and will be constructed as part of the Stucky Ridge RA.

5.1.1 Construction BMPs

Construction BMPs (e.g. silt fence) shall be implemented in areas of concentrated flow that could impact Lost Creek or Warm Springs Creek. BMPs will be implemented when construction operations are in progress in and around natural drainages. During site work activities, standard BMPs will be followed to divert storm water around the work area and to minimize storm water runoff from transporting sediments down-gradient to the extent practicable. These measures may include upgradient berms, straw bale check dams, temporary ditches and/or silt fence. See the Uplands CQAP Appendix C of this RAWP), and the Construction Storm Water Erosion Control Plan (Appendix D of this RAWP) for additional details.

5.1.2 Storm Water BMPs

Storm water BMPs have been selected to serve as both short- and long-term sediment and erosion control measures, and to assist in natural recovery of the drainages. An assortment of BMPs (referred to herein as the "toolbox") was developed. The intent of the BMPs is to enable the designer/field oversight to select one or more BMPs from a multitude of BMPs for use in areas of concern. The toolbox approach will enable similar design elements to be employed in each tributary, as required, and will result in increased design efficiency, construction efficiency and construction quality. Currently, the design tool box contains numerous types of BMPs that could be employed. Each BMP is applicable and most appropriate for a certain existing condition.

BMPs proposed for use at the site have been selected to address the varied and complex conditions present in the uplands areas. Many areas of the site have limited access. Erosion control measures may be limited to BMPs that can be installed using hand labor. Furthermore, it is considered prudent to install measures that will provide temporary sediment control during construction activities as well as provide long-term sediment/erosion control and enhance the stability of the drainages. BMPs such as dozer basins in steep slope areas, check dams (all types) and log grade control structures in ephemeral drainages, vegetative buffer strips around existing natural drainages, and brush boxes in steep slope areas will be used to reduce downgradient sediment transport during vegetation establishment (short-term) and to protect the long- term permanence of the remedy. Prescribed BMPs for the Stucky Ridge RA are provided on Sheet 6 of the Construction Drawings in Appendices A-1 through A-4. Specifications and construction details for the BMPs are provided in the Technical Specifications (Appendix B) and the Detail Sheets 0.3, 0.4, 0.5, 0.6 and 0.7 following Sheet 6 of the Construction Drawings in Appendix A.

5.1.3 Storm Water Engineered Controls

Two sediment ponds will be constructed to intercept storm water runoff from Stucky Ridge. One sediment pond (the North Sediment Pond) will be constructed near the northeast end of Stucky Ridge (See Sheet 6 of the Construction Drawings and associated SW Detail Sheets following Sheet 6 in Appendix A for location and construction requirements). This pond will intercept runoff in the existing storm water channel that conveys flows from the north side of Stucky Ridge and is designed to accommodate the 25 year, 24-hour storm event. The existing storm water channel will be re-constructed from the pond location west for approximately 6,000 feet and additional channels will be improved or reconstructed at each of three drainages to convey flows into the new intercept channel. Discharge from the sediment pond will flow into the existing storm water channel which drains to Gardiner Ditch.

Interceptor channels will be constructed along the east end of Stucky Ridge and immediately west of the Drag Strip (see Sheet 6 of the Construction Drawings and associated SW Detail Sheets following Sheet 6 in Appendix A). These channels will convey storm water runoff to a sediment pond constructed north of the Drag Strip, adjacent to Gardiner Ditch (the South Sediment Pond). Discharge from the south pond will flow into Gardiner Ditch. Detailed design for the storm water engineered controls is included in Appendix B.3 of the FDR.

5.2 Construction Quality Assurance

The Uplands CQAP presents QA/QC requirements for engineered storm water controls and storm water BMPs and general requirements for work identified in this RAWP. The CQAP is provided in Appendix C of this RAWP. The Construction SWECP presents requirements to control erosion due to storm events during construction activities and also includes requirements for controlling construction-related oils, fuels and other materials. The Construction SWECP is provided in Appendix D. Additional discussion on storm water control as part the uplands RA is discussed in Section 5.0.

The RA contractor shall verify that engineered controls/BMPs are constructed in compliance with the Specifications and Drawings in terms of product specifications and

using acceptable methodologies. Atlantic Richfield's Oversight representative shall observe and verify the RA contractor's compliance with the Drawings and Specifications.

5.3 Monitoring and Maintenance

Upon completion of RA construction activities by Atlantic Richfield Company and its contractors, Atlantic Richfield shall be responsible for maintaining the integrity of the storm water control structures, in accordance with the Final Monitoring and Maintenance (M&M) Plan.

6.0 GROUND WATER REMEDIAL ACTION

The ARWW&S OU ROD requires that long-term ground water monitoring be implemented at Waste Management Areas (WMA), Areas of Concern (AOC), and Technical Impracticability (TI) Zones.

In 1996, the EPA presented the *Ground Water Technical Impracticability Evaluation (TI) for the ARWW&S OU* (EPA, 1996). Results of this TI Evaluation revealed that arsenic concentrations exceeded the RA goals for arsenic (18 µg/L) in the bedrock ground water aquifer within portions of the Stucky Ridge TI Zone. The EPA granted a TI waiver of the arsenic performance standard in the ROD. Performance standards for cadmium, copper, lead, and zinc are effective in the TI Zone (EPA, 1998).

The Stucky Ridge TI Zone encompasses approximately ten square miles and RDU 1 is located primarily within the Stucky Ridge TI Zone boundary. The Stucky Ridge TI Zone is defined on the north, east and south by bedrock alluvium. The west end of the TI Zone is defined by a series of springs that were below the 18 µg/L standard specified in the ROD.

No active groundwater remedial action is required for the Stucky Ridge RDU. Rather this section describes the status of ground water conditions at the RDU and the use of ICs and/or monitoring for ensuring protectiveness of human health and the environment.

As a result of the elevated arsenic concentrations within RDU 1 ground water, a long-term Ground Water Monitoring program consisting of alluvial aquifer Performance Wells (PWs) and Point of Compliance (POC) monitoring wells, bedrock aquifer performance monitoring wells, and domestic wells will be implemented. The long-term Ground Water Management Plan (Atlantic Richfield, 2005b) attachment to the Sitewide M&M Plan describes in detail the monitoring requirements for the Stucky Ridge TI zone.

7.0 INSTITUTIONAL CONTROLS REMEDIAL ACTION

The Final Institutional Controls Management Plan (ICMP) (Atlantic Richfield, 2005c) in conjunction with the selected reclamation and engineering controls will include three basic components: land use restrictions and zoning, ground water controls, and public notices or advisories.

As outlined in the ROD, implementation of the Final ICMP, as applicable will:

- *Assure that future land and water use at the site is consistent with EPA's determination of the health and environmental risks posed by contaminants left on site;*

- *Provide for the preservation and maintenance of Superfund remedial structures on the site, including but not limited to engineered caps, covers, storm water conveyances, waste repositories and reclaimed areas;*
- *Require that future development at the site employ construction practices that are consistent with the protection of public health and the environment, as determined by Superfund remedial actions and in accordance with the requirements set forth by the Anaconda-Deer Lodge County Development Permit System;*
- *If development occurs at the site, implement the remediation of soil arsenic contamination to levels appropriate for the intended use, as determined by Superfund remedial actions;*
- *Provide for implementation of other laws applicable to development, such as subdivision and floodplain requirements; and*
- *Provide information and notice to the public (users or potential users of land or ground water) of some existing or impending risk associated with their use of the site.*

Additional information related to institutional controls implemented as part of the RD for each RDU will be discussed in the Final site-wide Institutional Controls Management Plan.

The revegetation design for each RDU is based on the current arsenic land use cleanup standard, in this instance, the agricultural/open space/wildlife habitat standard of 1,000 mg/kg and the industrial/commercial standard of 500 mg/kg. Residential areas and the corresponding human health action level (250 mg/kg) are addressed under the CSOU and through the Superfund Planning Area Overlay District portion of the Anaconda-Deer Lodge County (ADLC) Development Permit System (DPS). Future development of this area may trigger sampling/development and/or remediation requirements under the SPAOD portion of the DPS.

8.0 REMEDIAL ACTION CONSTRUCTION COMPLETION

Completion of seeding will mark the end of the construction. At the end of construction a walkthrough will be scheduled with the Agencies to verify construction completion and a Construction Completion Report (CCR) will be prepared and submitted to the Agencies.

8.1 Punchlist Inspection

Upon completion of each RA, a Final Inspection Form (CQAP – Appendix C) will be completed by an Atlantic Richfield Company representative and an Agency representative during the walkthrough as discussed in Section 4.8.1. The form is organized by work item and requires an inspection signoff of each work item completed.

8.2 Construction Completion Report

Upon completion of each RA, a final Remedial Action Construction Completion Report (RACCR) will be prepared. The purpose of this report is to compile all construction-related information into one comprehensive document. The RACCR will include

construction details, field design changes, RFCs, inspection and test results, corrective actions, photographs, As-Built drawings, QA/QC memoranda or reports and interpretations. The Report will also present the final overall project schedule, final inspection records, ARARs compliance approvals and material quantities used. This document will be submitted to the Agencies to obtain final certification and closure of the area.

8.2.1 As-Built Drawing Requirements

A master set of working construction drawings will be stored at the project trailer office. These drawings will be clearly and neatly updated to provide an "As-Built" record of all changes and modifications to the final design and specifications, with each modification being dated and signed by the Atlantic Richfield Company Project representative and the Agency oversight representative. All modifications must also be clearly documented and described on an accompanying RFC form as described in Section 1.2. These Drawings will also be periodically copied at regularly scheduled intervals to provide a backup record, and the duplicate set will be maintained at the Atlantic Richfield Company's office in Butte, Montana.

Upon completion of the RA, final As-Built Drawings will be prepared for inclusion in the RACCR to document the actual lines, grades and conditions of each component of the RA. These Drawings will be based on site observations or GPS survey data, if needed, to illustrate the dimensions, identify specific locations or the layout of specific construction activities and identify compliance with the design specifications and drawings.

9.0 MONITORING AND MAINTENANCE ACTIVITIES

Upon completion of RA construction activities by Atlantic Richfield Company and its contractors, as approved by the Agencies, Atlantic Richfield shall be responsible for maintaining the integrity of the remedy, in a manner consistent with the Monitoring and Maintenance (M&M) Plan, so as to minimize erosion or degradation of the remedy and to provide for the establishment of vegetative cover. Upon completion of the RA or achieving vegetation performance standards, as outlined in the Final M&M Plan, the landowner will be responsible for appropriate land management as outlined in the Landowner Agreement and as required under State and local ordinances.

9.1 Long-Term Monitoring and Maintenance

Once RAOs and ARARs have been achieved and documented as outlined in the M&M Plan, no additional monitoring by the PRP is required other than at 5-year reviews, as necessary.

10.0 PARTIAL DELETION

In accordance with the NCP and EPA guidance, portions of the Anaconda Smelter Site may be proposed for deletion from the National Priorities List following implementation of response actions or it the release of hazardous substances poses no significant threat to public health or the environment. The EPA's partial deletion rule, which was published in the Federal Register on November 1, 1995, allows EPA to delete a portion of an NPL site provided certain deletion criteria are met. The partial deletion rule specifically provides that petitions for delisting may be submitted to EPA by "any person, including

individuals, business entities, States, local governments and other Federal agencies." 60 Federal Register 55466 (Nov. 1, 1995). Partial delisting is governed by 40 Code of Federal Regulations (CFR) 300.425(e). 40 CFR 300.425(e).

11.0 REFERENCES

ADLC, 1992a. Anaconda-Deer Lodge County (ADLC) Master Plan. Prepared for the ADLC Planning Board by Robert Peccia & Associates and Lisa Bay Consulting. June 1992.

ADLC, 1992b. Development Permit System. December, 1992.

ARCO. 1992. Clark Fork River Superfund Site Investigation Standard Operating Procedures.

ARCO, 1994. Regional Historic Preservation Second Programmatic Agreement.

ARCO. 1996. Anaconda Regional Water and Waste Operable Unit Final Remedial Investigation Report. Prepared by Environmental Science & Engineering, Inc. for ARCO. February 1996, Volumes I - IV.

AERL 1999. Anaconda Regional Water, Waste and Soils OU and Old Works/East Anaconda Development Area OU, Wetland and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area, Anaconda Smelter NPL Site, May 1999.

Atlantic Richfield Company 2002a. Draft Final Warms Springs Creek and Lost Creek Storm Event Data Summary Report. Prepared for ARCO by Pioneer Technical Services. January 25, 2002.

Atlantic Richfield Company. 2002b. Final Data Summary Report (DSR) for Land Reclamation Evaluation System (LRES) Phase III Sampling and Analysis Plan (SAP), Volumes I and II. Anaconda, MT.

Atlantic Richfield Company. 2002c. Final Surface Water Technical Memorandum. Prepared for ARCO by Pioneer Technical Services. March 27, 2002.

Atlantic Richfield Company. 2005a. Final Design Report, Remedial Design Unit 1, Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. [IN PROGRESS]

Atlantic Richfield Company. 2005b. Anaconda Regional Water, Waste & Soils OU, Final Long-Term Ground Water Management Plan. [IN PROGRESS]

Atlantic Richfield Company. 2005c. Institutional Controls Management Plan, Anaconda Regional Water, Waste & Soils OU. Anaconda, MT. [IN PROGRESS]

CDM and RRU. 1998. Best Management Practices for Upland Reclamation Activities within the Clark Fork River Basin. Reclamation Research Unit, Montana State Univ., Bozeman, MT.

EPA. 1996. Draft Feasibility Study Deliverable No. 3A, Ground Water Technical Impracticability Evaluation, Anaconda Regional Water, Waste & Soils Operable Unit. Prepared by CDM Federal for EPA. December 19, 1996.

EPA and MDEQ. 1998. Record of Decision, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. September 1998.

EPA. 2000. Final Remedial Design Work Plan, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, MT. Prepared for EPA by CDM Federal Programs Corporation. June 26, 2000.

Montana Department of Environmental Quality. 1996. Montana Sediment and Erosion Control Manual. Prepared by Roxanne Lincoln CPSS, MPDES Storm Water Program. Revised May 1996.

APPENDIX A
CONSTRUCTION DRAWINGS
AND
DESIGN INFORMATION

APPENDIX A-1.1
CONSTRUCTION DRAWINGS
STUCKY RIDGE AREA NO. 1

APPENDIX A-1.2
DESIGN CRITERIA SUMMARY SHEETS
STUCKY RIDGE AREA NO. 1

APPENDIX F

COSTS

Costs for Remedy and Restoration Actions in this Plan

Costs are estimates, and based on 2007 dollars. All costs include a 20% cost and design contingency and 10% for O&M, monitoring and administration.[1] Total costs for Mount Haggin remedy and restoration is about $6.7 million. Total costs for Stucky Ridge, Section 36 remedy and restoration is about $2.8 million. Total costs for remedy and restoration in the State owned lands of Mount Haggin and Stucky Ridge is approximately $9.4 million dollars as outlined in the table below.

Area	Number of Acres	Total to Implement
Mount Haggin Restoration outside of Cabbage Gulch	850	$ 4,976,400
Cabbage Gulch Remedy	137	$ 1,194,375
Cabbage Gulch Restoration	137	$ 554,125
Remedy on Section 36 on Stucky Ridge	445	$ 1,153,945
Restoration on Section 36 of Stucky Ridge	445	$ 1,558,378
Total		**$ 9,437,223**

1) Costs for <u>Restoration</u> of Bare and Degraded Areas of Mount Haggin Injured Area

The restoration of the Mount Haggin Bare and Degraded Areas is estimated to cost $7.5 million.

The costing of the primary restoration components are as follows:

1. Lime application of half of 850 acres….$3,500/acre;
2. Tree and shrub planting on 80% of 850 acres…$2,500/acre;
3. Aerial fertilization of all 850 acres in years three and five …$250/acre;
4. Seeding of all 850 acres, some areas will require mechanical incorporation of seed….$500/acre.

Treatment	Number of Acres	Costs per acre	Total to Implement
Lime application	425	$3,500	$1,487,500
Tree/shrub planting	680	$2,500	$1,700,000
Aerial fertilization (years three and five)	850	$ 250	$ 215,500
Seeding and seed	850	$ 500	$ 425,000
Totals for Mount Haggin Restoration outside of Cabbage Gulch	850		$3,828,000 With 20% contingency/design and 10% for O&M, monitoring and administration **$4,976,400**

[1] The primary sources for costs are: 1) Rich Prodgers of Bighorn Environmental Sciences; 2) Dan Ueland of Western Reclamation; 3)BRI reports; and 4) Will Hogen of Hillworks.

Costs for remedy and restoration within the Mount Haggin Injured Area

The Cabbage Gulch combined restoration/remediation actions are estimated to cost about $1.8 million.

2) The costing of the primary <u>remedy</u> components on Cabbage Gulch are as follows:

1. Tree planting (500 plants/acre) on 112 acres of SSR areas… $2,500/acre;
2. Dozer basins on 18 acres… $2,500/acre;
3. Tillage to 6 inches on 16 acres and tillage to 12 inches on 9 acres…$140/acre;
4. Fertilization, lime application, 25 acres of tillage areas…$300/acre;
5. Seeding and seed for all 137 acres … $500/acre;
6. BMPs as suggested in design report… $100/acre as needed;
7. Weed control as necessary… $150/acre.
8. Muddy Creek Sediment pond (3 acre feet of storage); Cabbage Gulch Sediment Pond (7.2 acre feet of storage); Joyner Creek Sediment pond (12.1 acre feet of storage). Joyner Creek and Muddy Creek are located one and three miles south of Cabbage Gulch respectively.

Treatment	Number of Acres	Costs per Acre	Total to Implement
Tree/shrub planting	112	$2,500	$280,000
Dozer basins	18	$2,500	$ 45,000
Tillage 6/12 inch	25	$ 140	$ 3,500
Fertilization, lime application	25	$ 300	$ 7,500
Seeding and seed	137	$ 500	$ 68,500
BMP's	137	$ 100	$ 13,700
Weed control	137	$ 150	$ 20,550
Three Sediment ponds (20 acre feet of storage)	3		$ 480,000
Total for Cabbage Gulch Remedy including 3 detention basins			$918,750 With a 20% contingency/design and 10% O&M, monitoring and administration **$1,194,375**

3) Major <u>restoration</u> components on Cabbage Gulch are as follows:

1. Lime application at SSR areas…$3,500/acre;
2. Aerial fertilization of all 137 acres in years three and five…$250/acre.

Treatment	Number of Acres	Costs per acre	Total to Implement
Lime application	112	$3,500	$392,000
Aerial fertilization	137	$ 250	$ 34,250
Total for Cabbage Gulch Restoration			$426,250 With a 20% contingency/design and 10% O&M, monitoring and administration **$554,125**

Costs for the State-owned portion of Section 36 in the Stucky Ridge Injured Area

Costs for the Stucky Ridge, State-owned portion of Section 36 remedy/restoration component of this plan is estimated at about $2.8 million for this 480 area[2].

1) The major <u>remedy</u> components and associated costs are presented below.

1. Tillage of 335 acres to a depth of 12 inches… $140/acre for 2 passes;
2. Lime application to all 335 tillage areas at an estimated rate of 22 tons ($10/ton plus $70 for till…$300/acre;
3. Seeding on all 445 acres…$300 for seed plus $100 for seeding by hand and/or seeder…$400/acre;
4. Fertilizer in all 335 acres… $300/acre;
5. Shrubs/trees (500/acre) on all 90 acres of SSR areas…$2,500/acre;
6. Dozer basins on 50 acres of SSR areas…$2,500/acre;
7. Stone check dams/other BMPs, number to be determined… $100/acre;
8. Weed control as necessary …$150/acre.

Treatment	Number of Acres	Costs per Acre	Total to Implement
Tillage at 12 inches	335	$ 140	$ 46,900
Lime application	335	$ 300	$100,500
Seeding and seed	445	$ 400	$178,000
Fertilizer	335	$ 300	$100,500
Shrub/tree planting	90	$2,500	$225,000
Dozer basins	50	$2,500	$125,000
BMP's	445	$ 100	$ 45,000
Weed control	445	$ 150	$ 66,750
Total for Section 36 Remedy			$887,650 With a 20% contingency/design and 10% for O&M, monitoring, administration **$1,153,945**

[2] The actual remedy/restoration acres are 445 acres not 480 acres since 35 acres are slated as no action in remedial design documents.

2) The primary <u>restoration</u> components on the State-owned portion of Section 36 are:

1. Lime application of 90 acres of SSR areas… $3,500/acre;
2. Stripping and grading and on site disposal on some of the 335 acres of tillage areas … $1,000/acre;
3. Planting of Shrubs and trees on half the tillage and rock areas …$2,500/acre on 177 acres;
4. Enhanced seed not used in remedy. This seed will include shrub seed…. costs in remedy above;
5. Arial fertilization of all 335 acres of tillage areas and all 90 acres of SSR areas in years three and five… $250/acre.

Treatment	Number of Acres	Costs per Acre	Total to Implement
Lime application	90	$3,500	$315,000
Stripping/grading	335	$1,000	$335,000
Shrub/tree planting	177	$2,500	$442,500
Arial fertilization	425	$ 250	$106,250
Total costs for Section 36 Restoration			$1,198,750 With a 20% contingency/design and 10% for O&M, monitoring, administration **$1,558,378**

Appendix G

State Consent Decree Obligations

Consent Decree Obligations of the State

The *Consent Decree for the Clark Fork River Operable Unit and for Remaining State of Montana Clark Fork Basin Natural Resource Damages Claims*, Civil Action No. CV89-039-BU-SEH (Clark Fork Site Consent Decree) contains some important commitments made by the State at State-owned property within the Injured Areas. In addition, the State has made specific commitments to the Atlantic Richfield Company (AR) in State CD II. Also, the State has made several commitments contained in a Site Specific Memorandum of Agreement (SMOA) between EPA and the State. The commitments contained in these documents are summarized below. In the case of conflict between this summary and the consent decrees and the SMOA, the provisions of the consent decrees and the SMOA will control.

1. Use of Restoration Account. The State commits to use the Smelter Hill Area Uplands State Restoration Account to restore, rehabilitate, replace or acquire the equivalent of the injured natural resources as provided in this DCRP. This includes implementation of the State Property Remedial Commitments discussed below, including implementation of the work, attainment of performance standards, emergency response, and additional remedial work. The use of the restoration account also includes reimbursement to AR should EPA order AR to perform any activities the State is required to perform.

2. Commitment to perform remedial action on certain State-owned lands (State Property Remedial Commitments). The State commits to perform the work on the State-owned portion of Section 36 set forth in the RDU 1 Stucky Ridge FDR/RAWP (June 2005) as provided for in this DCRP. The State also commits to perform the work identified in the RDU 15 Mount Haggin Uplands FDR/RAWP (December 2007) as provided for in this DCRP. This work, together with certain potential additional response actions, comprise the State Property Remedial Commitments under the Clark Fork Site Consent Decree. The State commits to perform additional response actions within the "scope of the remedy selected in the ARWW&S OU ROD to be implemented by the State Property Remedial Commitments," as defined in Subparagraph 66.b of the Clark Fork Site Consent Decree if necessary to achieve and maintain the performance standards set forth in this DCRP or maintain the effectiveness of the portion of the remedy implemented by the State, as provided for in Subparagraph 66.b. of the Clark Fork Site Consent Decree.

3. Compliance with laws. The State commits to implement the State Property Remedial Commitments in accordance with federal and state law, including ARARs.

4. Emergency Response. The State commits to implement emergency measures in the event of a release or threatened release during performance of the State Property Remedial Commitments at the State-owned property.

5. Additional Remedial Work. The State commits to AR to perform additional response actions, if any, or pay costs of response actions, if any, at State Lands as defined in State CD II, as provided for in State CD II.

6. EPA Approvals. The State commits to EPA approvals of all required plans and reports set forth below, pertaining to the design and implementation of the State Property Remedial Commitments, subject to dispute resolution.

Specific plans and reports requiring EPA concurrence or approval for RDU 1 (State-owned portion of Section 36) and RDU 15

- Amendments to the Smelter Hill Area Uplands Resources Restoration Plan revising the nature or extent of the performance standards for the State Property Remedial Commitments.

- Remedial Action Work Plan for RDU 1 (for the State owned portion of Section 36) (finalized and approved), Remedial Action Work Plan for RDU 15 (finalized and approved), and as set forth in the Remedial Action Work Plans, the following for each: an operation and maintenance plan, vegetation management plan, inspection & maintenance plan for engineered controls (e.g., sediment basins), a pre-construction summary, including pre-design (polygon delineation, organic matter investigation, lime evaluation, construction BMPs, etc.), wetland delineation discussion, historic and cultural review discussion, endangered species discussion, and health and safety plan, and a remedial action schedule. The State will incorporate operable unit-wide plans where appropriate. Unless a plan has otherwise been previously finalized and approved, a draft of these plans will be provided to EPA for review and comment, and final plans, except for health and safety plans, are subject to EPA approval.

- Request for Change (RFC) – such as design changes

- Remedial Action Construction Completion Report, including as built drawings, RFCs, quality assurance results, and confirmation sampling, if any

- Annual Monitoring and Maintenance Report for vegetation and sediment basins

- Request for Maintenance (RFC during O&M)

- Performance Standard Compliance Determination Reports

- Institutional Control Plans for State Property Remedial Commitments

- Step 4 Wetland Accounting

- Modification to seed mixes

- Any short term vegetation monitoring plans

- O & M plans, including any surface water management plan, vegetation management plan, groundwater management plan, and engineered controls inspection and management plan.

- Plans required under the additional work provision

7. **Commitment to attain Performance Standards.** The State Property Remedial Commitments include the attainment of performance standards, including ARARs, set forth in the ARWWS ROD and its upcoming ESD.

RDU 1 Performance Standards

The State's implementation of the State Property Remedial Commitments includes the attainment of performance standards identified in the Remedial Action Work Plan / Final Design Report for the State-owned portion of Section 36 in Remedial Design Unit 1 of the Anaconda Smelter NPL Site (June 2005) as provided for in this DCRP. No attainment by the State of these performance standards is required outside of the State-owned portion of Section 36 within RDU 1. The performance standards set forth in the Remedial Action Work Plan / Final Design Report for Remedial Design Unit 1 and its associated management plans are summarized below. In the case of conflict between the provisions in this paragraph and the Remedial Action Work Plan / Final Design Report for Remedial Design Unit 1 and its associated management plans, the provisions the Remedial Action Work Plan / Final Design Report for Remedial Design Unit 1 and its associated management plans will control.

- *Vegetation / Soils.* On the State-owned portion of Section 36, the soils cannot exceed the human health arsenic level for the land use. For the RDU 1 State-owned property, that level is 1,000 ppm arsenic, with the exception of steep slopes areas, where the performance standard is 2,500 ppm. The vegetation performance standards that must be met on the State-owned portion of Section 36 will be set forth in the upcoming site-wide Vegetation Management Plan.[1]

- *Surface water*. The surface water performance standards that must be met on the State-owned portion of Section 36 will be set forth in the upcoming site-wide Surface Water Management Plan and any drainage specific surface water management plan.[2] There is no surface water within the State-owned portion of Section 36. However, a portion of Section 36 drains toward Lost Creek and a

[1] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

[2] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

portion of the area drains toward Warm Springs Creek. Attainment of surface water performance standards on the State-owned portion will likely be limited to implementation of best management practices (i.e.., dozer basins), engineered controls, and vegetative cover on the State-owned portion of Section 36.

- *Groundwater.* The groundwater performance standards that must be met on the State-owned portion of Section 36 will be set forth in the upcoming site-wide upcoming Groundwater Management Plan.[3] The groundwater standard for arsenic for the alluvial and bedrock aquifers beneath the State-owned portion of Section 36 has been waived. Attainment of groundwater performance standards on the State-owned portion will be limited to implementation of a vegetative cover.

- *Air.* The FDR requires standard construction practices, such as periodic dust suppression, to attain these standards during construction activities on the State-owned portion of Section 36.

- *Institutional controls.* The institutional controls performance standards that must be met on the State-owned portion of Section 36 will be set forth in the site-wide Institutional Controls Management Plan.[4]

- *Special resources.* The FDR requires compliance with requirements related to special resources, such as endangered species and historic properties on the State-owned portion of Section 36.

RDU 15 Performance Standards

The State's implementation of the State Property Remedial Commitments includes the attainment of performance standards identified in the Remedial Action Work Plan / Final Design Report for RDU 15 of the Anaconda Smelter NPL Site (December 2007) as provided for in this DCRP. The Remedial Action Work Plan / Final Design Report contemplates construction actions within the 137 acre Cabbage Gulch area in the north end of the Mount Haggin Injured Area. The Remedial Action Work Plan / Final Design Report does not require physical actions in the Mount Haggin Injured Area outside of the 137 acre Cabbage Gulch area other than monitoring, weed spraying, and, for Cabbage Gulch, Muddy Creek basin and Joyner Creek basin, the installation of a sedimentation basin at the mouth of each. No attainment of vegetation performance standards will be required in Remedial Design Unit 15 outside of the 137 acre Cabbage Gulch area; however, EPA may require additional vegetation in RDU 15, as provided in Subparagraph 66.b of the Clark Fork Site Consent Decree, if necessary to meet the surface water and groundwater performance standards as set forth below. The performance standards set forth in the Remedial Action Work Plan / Final Design Report

[3] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

[4] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

for Remedial Design Unit 15 and its associated management plans are summarized below. In the case of conflict between the provisions in this paragraph and the Remedial Action Work Plan / Final Design Report for Remedial Design Unit 15 and its associated management plans, the provisions the Remedial Action Work Plan / Final Design Report for Remedial Design Unit 15 and its associated management plans will control.

- *Vegetation / Soils.* Within RDU 15, the soils cannot exceed the human health arsenic level for the land use. For steep slope areas within RDU 15, the performance standard is 2,500 ppm arsenic. The performance standard for soils in any remaining areas is 1,000 ppm arsenic. The vegetation performance standards that must be met within RDU 15 will be set forth in the upcoming site-wide Vegetation Management Plan.[5]

- *Surface water.* The surface water performance standards that must be met at RDU 15 will be set forth in the site-wide Surface Water Management Plan.[6] The final performance standards pertaining to RDU 15 are identified in the Mill Creek SWMP, a component of the site-wide Surface Water Management Plan. RDU 15 is within the Mill Creek basin, and is one of the contributors to Mill Creek surface water.

- *Groundwater.* The groundwater performance standards that must be met in RDU 15 will be set forth in the site-wide Groundwater Management Plan.[7] The groundwater standard for arsenic for the bedrock aquifer beneath RDU 15 has been waived. Attainment of groundwater performance standards in RDU 15 will be limited to implementation of a vegetative cover.

- *Air.* The FDR requires standard construction practices, such as periodic dust suppression, to attain these standards during construction activities in RDU 15.

- *Institutional controls.* The institutional controls performance standards that must be met in RDU 15 will be set forth in the site-wide Institutional Controls Management Plan.[8]

- *Special resources.* The FDR requires compliance with requirements related to special resources, such as endangered species and historic properties in RDU 15.

[5] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

[6] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

[7] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.

[8] This plan is being developed by AR, and will be subject to review and approval by EPA and Montana DEQ.